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January 18, 2018

Mr. Davis Zhen, Project Coordinator
U.S. Environmental Protection Agency
1200 6th Avenue
Seattle, Washington 98101

Subject: **Portland Harbor Superfund Site**
Pre-Remedial Design (Pre-RD) Investigation and Baseline Sampling
Subsurface Sediment Coring Field Sampling Plan
CERCLA Docket No. 10-2018-0236

Dear Mr. Zhen:

On behalf of the Pre-RD AOC Group, AECOM is pleased to submit the Subsurface Sediment Coring Field Sampling Plan (FSP) in accordance with the Administrative Settlement Agreement and Order on Consent (ASAOC) for Pre-RD Investigation and Baseline Sampling.

The attached document describes the activities to be performed in compliance with the Statement of Work Section 3.1 "Scope of Pre-Remedial Design Investigation (PDI)" and Section 5.7(c) "Supporting Deliverables to PDI Work Plan" approved by the U.S. Environmental Protection Agency (EPA) as part of the ASAOC.

We understand the EPA has 30 days to review the attached document. In the interest of expediting the project, we encourage a meeting to assist with a timely review and approval process.

Again, on behalf of the Pre-RD AOC Group, we are pleased to submit the referenced document and look forward to assisting in the review process.

Sincerely,

Kenneth Tyrrell

Kenneth M. Tyrrell
AECOM Project Coordinator
Executive Vice President
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Copies: Pre-RD AOC Group, Mr. Hans Feige

AGENCY REVIEW DRAFT

Subsurface Sediment Coring Field Sampling Plan

Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling

Portland Harbor Superfund Site

AECOM Project Number: 60554349
Geosyntec Project Number: PNG0767A

January 18, 2018

Prepared for:

United States Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
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On behalf of:

Portland Harbor Pre-RD AOC Group
Portland, Oregon

Prepared by:

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CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Kenneth M. Tyrrell PDI Project Coordinator AECOM Technical Services	January 18, 2018 Date

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ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services
ALS	ALS Environmental
Alt F Mod	Alternative F Modified SMA footprint
ASAOC	Administrative Settlement Agreement and Order on Consent
bml	below mudline
ASTM	American Society for Testing and Materials
COCs	contaminants of concern
CRD	Columbia River Datum
CSM	Conceptual Site Model
DDT	dichlorodiphenyltrichloroethane
DDx	DDT and its derivatives
DGPS	differential global positioning system
D/F	dioxin/furans
DQMP	Data Quality Management Plan
EPA	United States Environmental Protection Agency
FC	Field Coordinator
FS	feasibility study
ft	foot/feet
FMD	future maintenance dredge area
FSP	Field Sampling Plan
Geosyntec	Geosyntec Consultants, Inc.
Gravity	Gravity Marine Services
ID	identification number
IDW	investigation-derived waste
LWG	Lower Willamette Group
MHW	mean high water
NAD	North American Datum
NAPL	non-aqueous phase liquid
NAVD88	North American Vertical Datum of 1988
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PID	photoionization detector
PDI	Pre-Remedial Design Investigation
PHSS	Portland Harbor Superfund Site
PRD	Portland River Datum

Pre-RD AOC Group	Pre-Remedial Design Agreement and Order on Consent Investigation Group
Pre-RD	Pre-Remedial Design
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAL	Remedial Action Level
RI	remedial investigation
RM	river mile
ROD	Record of Decision
Site	Portland Harbor Superfund Site
SMA	sediment management area
SOPs	Standard Operating Procedures
SOW	Statement of Work
TestAmerica	TestAmerica Laboratories
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

1. INTRODUCTION

The Record of Decision (ROD) described a post-ROD sampling effort for the Portland Harbor Superfund Site (Site or PHSS; Figure 1) located in Portland, Oregon, to delineate and better refine the sediment management area (SMA) footprints, refine the Conceptual Site Model (CSM), determine baseline conditions, and support remedial design (United States Environmental Protection Agency [EPA] 2017a). Geosyntec Consultants, Inc. (Geosyntec), and AECOM Technical Services (AECOM) submitted a detailed Work Plan for Pre-Remedial Design Investigation and Baseline Sampling (PDI) on behalf of a group of industrial parties called the Pre-Remedial Design Agreement and Order on Consent Investigation Group (Pre-RD AOC Group). On December 19, 2017, EPA entered into an Administrative Settlement Agreement and Order on Consent (ASAOC) with the Pre-RD AOC Group to conduct the PDI studies at the Site (EPA 2017b). The ASAOC includes a Statement of Work (SOW) and the PDI Work Plan (as an attachment to the SOW), which generally describe the agreed upon field investigation activities, data analyses, schedule, and deliverables for the PDI.

These PDI studies are a foundational step in what will be a multi-phase effort to update current conditions from the collection of data during the remedial investigation (RI)/feasibility study (FS). The RI/FS was initiated by a group of potentially responsible parties known as the Lower Willamette Group (LWG) and completed by EPA in 2016 (EPA 2016a, 2016b). The RI consisted of three rounds of data collection, including surface and subsurface sediment, shoreline/nearshore soils, surface water, sediment traps, porewater, fish tissue, and other media from 2001 through 2007.

This Field Sampling Plan (FSP) was prepared to support the subsurface sediment sampling outlined in the PDI Work Plan (Geosyntec 2017) and the project Quality Assurance Project Plan (QAPP) (AECOM and Geosyntec 2018a). To the extent practicable, previously approved FSPs and standard operating procedures (SOPs) from the RI will be referenced.

1.1 Project Setting

The PHSS is located in Portland, Oregon, on the lower Willamette River immediately downstream of the urban downtown area from river mile (RM) 1.9 upstream to 11.8 and covers 2,190 acres. There are two reaches located immediately upstream of the Site. The Downtown Reach, which includes the urbanized area of downtown Portland, is defined by EPA as extending from RM 11.8 to RM 16.6. EPA defines the Upriver Reach as extending from RM 16.6 to RM 28.4. Collectively, RM 11.8 to RM 28.4 is referred to as the D/U Reach.

The bathymetry elevation for most of the Site is from -30 to -50 feet (ft) Columbia River Datum (CRD) and is dominated by the authorized federal navigation channel (EPA 2017a). This channel, extending nearly bank-to-bank in some areas, doubles the natural depth of the river and allows transit of large ships into the active harbor; the PHSS serves as a major shipping route for containerized and bulk cargo. Elevations in the federal navigation channel are generally -40 to

-50 ft CRD, and the authorized depth is -40 ft CRD (or about -35 ft North American Vertical Datum of 1988 [NAVD88]). The CRD vertical datum is used by the U.S. Geological Survey (USGS) and U.S. Army Corps of Engineers (USACE); however, the primary vertical datum used for the PDI studies will be NAVD88.[1] The USGS gauging stations is located at the Morrison Bridge at RM 12.8; river levels recorded by that gauge are reported in Portland River Datum (PRD). Additional shipping and berthing areas were identified in the ROD as future maintenance dredge (FMD) areas with potential maintenance dredging requirements.

The remedy selected in the ROD (EPA 2017a), called the Alternative F Modified SMA footprint (Alt F Mod), identified 394 acres of engineered remediation with a combination of remedial technologies. The PDI subsurface sediment sampling activities are focused on refining the horizontal and vertical extent of contamination in these areas, especially the SMA areas targeted for dredging or partial dredging/capping. A total of 90 PDI cores are proposed to reduce this uncertainty. In addition, a surface sediment grab sample will be collected from each deep, in-water core location per protocols outlined in the surface sediment sampling FSP.

Subsurface sediment samples will be analyzed for the focused contaminants of concern (COCs), which include dichlorodiphenyltrichloroethane (DDT) and its derivatives (DDx), polychlorinated biphenyls (PCBs, as Aroclors), polycyclic aromatic hydrocarbons (PAHs), and dioxin/furans (D/F).

1.2 Data Quality Objectives

The purpose of the subsurface sampling effort is to refine the CSM for the Site, help reduce the uncertainty and refine the SMA footprints, and help evaluate concentration changes over time for focused COCs that have remedial action levels (RALs). Subsurface sediment sampling will be conducted in targeted areas within or along the boundaries of SMAs that have limited subsurface data coverage with the purpose of refining the active footprint boundaries of the Alt F Mod SMAs and collect data to support the allocation process. PDI subsurface data will be collectively viewed with historical RI subsurface data, new PDI bathymetry, and new PDI surface sediment data to update the CSM relative to subsurface conditions. Pre-remedial design investigation data quality objectives and data use objectives are presented in the PDI Work Plan (Geosyntec 2017).

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[1] CRD is used as the nautical chart datum for the lower Willamette River, using a reference plane established by the USACE in 1912. Because this datum is based on water elevations throughout the river, CRD is not a fixed/level datum but slopes upward as one moves upstream. Therefore, the NAVD88 fixed vertical datum will be the primary datum used in the PDI studies. The difference between the two datums is about 5.2 vertical ft within the Site. For reference, at RM 1.3 the difference is 5.4 ft, and at RM 12.8 the difference is 4.6 ft.

2. SAMPLING DESIGN AND APPROACH

A total of 90 core locations, presented in Figure 2a through 2f, have been selected for the PDI study to refine the spatial extent (horizontal and vertical) of the Alt F Mod active SMA remedial footprint. Methods for subsurface sediment sampling are generally consistent with EPA-approved sampling plans from the RI (Integral 2002, 2004, 2006), EPA guidance on collecting and processing sediment data (EPA 2014), and Puget Sound Estuary Program (PSEP) protocols (PSEP 1986).

2.1 Previous LWG RI/FS Subsurface Sediment Coring

The LWG completed three rounds of field sampling between 2002 and 2008 for the RI/FS. Subsurface sediment core sampling is summarized below.

- Subsurface samples were collected during the Round 2 field sampling event (2004-2005) in two phases: Round 2A and Round 2B (Integral and Anchor 2005; Integral 2005).
    - During Round 2A coring between September and November 2004, a total of 218 cores were collected from 200 locations within RM 2 and RM 10. A total of 717 subsurface sediment samples were submitted for laboratory analyses.
    - During Round 2B coring in October 2005, a total of 181 subsurface samples were collected from 42 locations between RM 3.5 to RM 10.
- Subsurface sediment samples were collected during the Round 3 field sampling event (2007-2008) in two phases: Round 3A and Round 3B (Integral 2007, 2008).
    - During Round 3A coring in January and February 2007, subsurface samples were collected upstream between RM 9.5 and RM 12 and downstream of the Site between RM 0.9 and RM 1.9. A total of 24 sediment cores were collected from 18 locations in the upstream and downstream reaches combined, and 106 subsurface sediment samples were submitted for laboratory analyses.
    - During Round 3B coring between November 2007 and January 2008, a total of 94 subsurface cores were collected from 88 locations within three reaches: 1) the Site and slightly upriver of the Site between RM 2 and RM 12.2, 2) the upper reach of the Multnomah Channel, and 3) upriver between RM 15.3 and RM 26. A total of 244 subsurface sediment samples were submitted for laboratory analyses.

2.2 Sediment Core Location Rationale

Proposed and historical core locations are presented on Figures 3a through 3h. Placement of the 90 proposed core locations were based on the visual assessment of subsurface contamination using 250- to 300-ft distance as a general guidance to the next nearest coring location. In some cases, stations will be re-occupied to determine the vertical extent of contamination, or a new core will be collected in an SMA where none previously existed. Proposed core locations and depths were selected to target spatial gaps from the RI subsurface data. Rationale for placement of PDI cores were based on the following concepts relative to the subsurface:

- **Spatial Resolution**. For portions of SMAs with limited subsurface data, cores were located to achieve an approximately 250 to 300 ft spacing distance to the next nearest historical coring location within an SMA, to refine the spatial resolution between data and provide improved understanding of subsurface concentration gradients between samples.
- **Horizontally Unbounded.** For spatial boundaries of SMAs with limited historical core coverage near the boundaries of a cleanup footprint, especially in dredge areas, cores were located to refine the horizontal extent of subsurface data in dredge footprints where SMAs are horizontally unbounded. This particularly applies to subsurface volume estimates toward the navigation channel.
- **Vertically Unbounded**. For portions of SMAs with historical cores, where the extent of subsurface contamination is vertically unbounded (did not "tag bottom" with a confirmed chemical concentration at depth below RALs), new PDI cores were located in the general vicinity of these RI stations (re-occupied station) to identify the vertical extent of contamination. As stated in the ROD, contamination in the subsurface sediment was identified as deep as 17 ft below mudline (bml) in the navigation channel and 19 ft bml in other areas (EPA 2017a).
- **No Subsurface Data**. For SMAs, especially those designated in the ROD for dredging, where no subsurface data previously existed, cores were located to define subsurface concentrations with depth in these areas. However, these small areas may be contouring artifacts within the GIS program and may not represent actual areas of subsurface contamination. These areas will be reviewed in more detail and discussed with EPA prior to starting field work, to determine if a core is necessary in these isolated areas.
- **Nearshore Data Coverage.** For portions of SMAs with limited near-shoreline shallow cores, or no cores, PDI cores were placed in nearshore areas to provide spatial coverage towards shore for large dredging footprints, where no subsurface data exists. In the shallow region, the maximum depth of contamination was estimated to be 3.5 ft bml (EPA 2017a). Six ft depths are targeted for these nearshore (shallow) areas.
- Cores were not located in areas where remedial caps have already been placed or in the RM 11E early action area where additional subsurface data have already been collected in the last few years and remedial design negotiations are currently underway between EPA and the RM 11E Group.

With respect to elevations and depths bml, the ROD describes three Site regions: 1) the navigation channel and FMD areas, 2) the intermediate region (outside the navigation channel and FMD areas to -2 ft CRD [about +3 ft NAVD88]), and 3) the shallow region (shoreward of -2 ft CRD). The ROD indicates sediment with concentrations above the RALs will be dredged to at least 5 ft bml, where practicable. For the navigation channel/FMD and intermediate region, deep cores will be advanced 10 to 20 ft bml depending on the estimated vertical extent of contamination in a SMA; these cores are referred to as deep cores because they are generally located in deeper water compared to the nearshore cores. For the shallow region, cores located in the nearshore area will be advanced to a depth of 6 ft bml; these cores are referred to as nearshore cores. Deeper depth intervals will be archived.

A fourth region, the riverbank region (defined as the “top of bank down to the river” in the ROD) is not included in this PDI study. The riverbank region will be addressed on a site-specific basis by EPA as part of PHSS remedial activities or Oregon Department of Environmental Quality under source control. This PDI study is focused in areas below the shoreline defined generally as the mean high water [MHW] (8 ft CRD, which is equal to about +13 ft NAVD88).

2.2.1 Example Cross Sections

Cross sections of four large SMAs were developed to help illustrate core location selection rationale (Figures 4a through 4d). Cross sections were drawn for SMAs with six or more PDI cores and large Alt F Mod active remedial footprints. Each cross section shows a mudline elevation bathymetry contour, historical RI surface sediment grabs and subsurface core locations, total PCB and total PAH concentration data (horizontally and vertically), and proposed PDI core locations. Areas with steeper slopes show two mudline bathymetry contour lines: a nearshore line and a toe of slope line. The cross-section figures are summarized below, and a core-by-core rationale is provided in Table 1.

- In Figure 4a (section A-A’ RM 1.9 to RM 2.7), the cross section illustrates the limited subsurface data at the downstream end of the SMA (RM 2) and at the upstream end (RM 2.5); three cores are proposed in these areas. In the middle of the SMA (RM 2.3), PCB RAL exceedances extend to the bottom of the PDI cores (depth of contamination is vertically unbounded); four cores are proposed to fill this area. The last proposed core (RM 2) is located as a result of data greater than 300 ft apart and have varying depths of contamination between existing data.
- In Figure 4b (section B-B’ International Slip), a total of seven cores are planned. Four PDI cores are located in areas with less dense historical sampling in the mouth and middle portions of the slip where contaminant thicknesses vary. Three additional PDI cores will confirm the vertical depth of contamination near the head of the slip, as a result of historical cores vertically unbounded. The step-wise mudline contours of previously dredged areas are also visible in Figure 3b.
- In Figure 4c (section C-C’ RM 6.8 to RM 7.5), large remedial dredging areas are identified in the downstream shallow areas where cores are limited, and those that exist are vertically unbounded (depth of contamination is not confirmed). The upstream area has several RI cores that are vertically unbounded at depth for total PCBs. The proposed PDI cores in the downstream area will provide spatial coverage of the vertical extent of

contamination. The two upstream PDI cores are intended to confirm the vertical depth of contamination; this SMA has PAH and D/F exceedances vertically unbounded.

- In Figure 4d (section D-D' Swan Island Lagoon), seven PDI cores are proposed over the length of the lagoon for spatial coverage, and four of seven cores near the head of the lagoon are intended to confirm the vertical extent of PCB contamination exceeding RALs (some of the historical cores are vertically unbounded).

2.2.2 Sample Types, Locations, Depths

Subsurface sediment cores will be collected across the Site between RM 1.9 and RM 11.8 based on the rationale described in Section 2.2.1. Proposed locations are presented on Figures 2a through 2e. Subsurface sediment samples from shallow (nearshore) cores will vary in target collection depth from 0 to 6 ft for (shallow nearshore region) and from 0 to 20 ft target depth for the deep cores (navigation channel/FMD and intermediate region). Most of the deep cores will be driven 15 ft bml or until refusal. Core locations may be modified based on the bathymetry, surface sediment sampling work, contouring artifacts, or other additional information with EPA approval. Table 1 presents the location, core depths, location identification numbers (IDs), and rationale for subsurface sediment location selection based on the criteria described above.

Subsurface core samples will be visually logged and processed at 2 ft intervals (continuous intervals) along the entire length of the accepted core, unless core stratigraphy indicates otherwise (see discussion in Section 4.4). The first sample will be collected from the 0 to 2 ft interval, regardless of stratigraphy. One ft sample intervals may be collected and archived from the area expected to be the bottom of contamination, to potentially provide a refined depth of contamination. The very bottom of retained sediment from the core, regardless of the bottom sample interval thickness, will also be processed and archived, pending results of the upper intervals (especially for the nearshore cores).

Subsurface sample counts and selected analytes are presented in Table 2. The 60 deep cores will be collocated with PDI surface sediment grab locations collected from the 0 to 30 centimeter (0 to 1 ft) interval. Proposed subsurface core station IDs, mudline elevations, and coordinates are presented in Table 3. Figure 2 presents the proposed core locations within the Site. Core location and sample IDs will correspond with the surface sediment station ID; therefore, the core station IDs will not be numerically sequential.

2.2.3 Sample Nomenclature

The sample identification scheme for subsurface sediment sample collection will utilize a three-letter project identification code followed by a three-letter sample matrix code, unique station code, and sample depth interval. See the project QAPP (AECOM and Geosyntec 2018a) for details. In summary, the identification scheme follows:

- Project phase (PDI).

- Sample matrix (SC [sediment core]).
- Unique, sequential station number (S001 to S263). Station numbers are based on placement within the location of the river (from downstream to upstream). Collocated sediment grabs and cores (non-random) are all grouped together for numbering purposes.
- Sample interval depth (2 ft up to 20 ft).

For example, a subsurface sediment core at station 10 collected from a depth interval of 6 to 8 ft would have the sample ID PDI-SC-010-6to8. See Section 4.2.1 of the QAPP for nomenclature associated with field duplicates and other quality assurance (QA)/quality control (QC) samples. Additional data fields that describe each unique sample and core location will be recorded in the field forms and will be included in the project database, as described in the project Data Quality Management Plan (DQMP) (AECOM and Geosyntec 2018b). These may include, for example, core recovery, *in situ* sample depth, recovered sample depth, mudline elevation, RM, SMA ID, and collection method.

2.3 Sampling Schedule

Subsurface sediment coring is targeted for the second and third quarters of 2018 (beginning May/June), after the surface sediment sampling and bathymetry survey have been completed, and before fish tissue sampling begins in July/August 2018. Subsurface sediment coring is expected to last 3 weeks using two sampling vessels (one vessel for deep coring and another vessel for the nearshore coring). After 2 weeks into the coring program, field progress will be assessed, and if it appears that the sampling effort is behind schedule, a third vessel and crew will likely be mobilized to complete the coring in the targeted sampling period.

2.4 Key Changes from Previously Approved RI FSPs

Subsurface sediment coring will be performed in accordance with RI project plans (Integral 2002, 2004, and 2006), except as noted in the bullets below and Section 4. SOPs from the RI will be made readily available as hard copies and PDFs on SharePoint for field staff to reference before and during field work. Key PDI changes from the RI Round 2 FSP – Sediment Sampling and Benthic Toxicity Testing (Integral 2004) include the following:

- Subsurface sediment samples will only be analyzed for the focused COCs (PCB Aroclors, PAHs, D/F, DDx), grain size, total solids, and total organic carbon (TOC). A portion of the fine-grained samples may be submitted for additional geotechnical properties using Atterberg Limits test (ASTM D4318).
- The SOP from the RI described several different coring methods; the PDI study is intending to use a vibracore, but may consider other equipment (piston core, high frequency impact core or other device) for difficult areas that previously hit refusal (e.g., gravel) or areas with potential non-aqueous phase liquid (NAPL) (near RM 6 and RM 7) to help better refine the extent of NAPL.

- In areas with potential NAPL, a jar sheen test and Field Description Key will be used during core processing(see Appendix B). When coring in areas with potential NAPL, sorbent booms and pads may be proactively deployed around the coring area and the coring equipment/vessels to minimize dispersion of NAPL sheens that may appear on the water surface.
- Subsurface sediment cores will be processed for analytical testing at 2 ft intervals, unless strong stratigraphy indicates otherwise; the RI discussed sample thickness ranging from 1 to 4 ft.

3. PROJECT ORGANIZATION/FIELD TEAM

3.1 Team Organization and Responsibilities

Team organization is detailed in the PDI Work Plan and in Section 2 of the QAPP (AECOM and Geosyntec 2018a). As it relates to this FSP, AECOM and Geosyntec are coordinating activities including management of all subcontractors, field sampling, analysis, and reporting scoping tasks. The PDI Project Coordinator, Mr. Ken Tyrrell, and PDI Project Manager, Dr. Jennifer Pretare, PhD (AECOM), will be responsible for overall project coordination and providing oversight on all project deliverables. Ms. Anne Fitzpatrick (Geosyntec) is the senior technical lead for this task. Ms. Nicky Moody (AECOM) and Mr. Keith Kroeger (Geosyntec) will be the Field Coordinators (FCs) and will be generally responsible for general field QA/QC oversight. The project chemists, Ms. Julia Klens-Caprio (Geosyntec), Ms. Amy Dahl (AECOM), and Ms. Karen Mixon (AECOM), will be responsible for coordination with labs regarding sample volumes, logistics, schedule, detection limits and matrix interferences, and ensuring overall data quality.

Gravity Marine (Gravity), of Fall City, Washington, will perform vessel support, with Mr. Shawn Hinz acting as a point of contact. Analytical laboratories include ALS Environmental (ALS) in Kelso, Washington, and TestAmerica Laboratories (TestAmerica) in Fife, Washington, Sacramento, California, and Knoxville, Tennessee. Additional coring contractors and equipment may be mobilized if needed, to improve core recoveries in difficult areas (e.g., refusal, large wood debris, gravel, cobbles, etc.)

3.2 Communication/Information Flow

The communication strategy is outlined in Section 2 of the QAPP (AECOM and Geosyntec 2018a). The FCs, Ms. Nicky Moody (AECOM) and Mr. Keith Kroeger (Geosyntec), will be the points of contact for field staff during the implementation of this FSP. Anne Fitzpatrick (Geosyntec) will be the senior technical lead consulting with the field staff on core placement and interpretations, as needed, for this task. Deviations from this FSP or the project-specific QAPP will be reported to the PDI Project Manager for consultation. Significant deviations from the FSP/QAPP will be further reported to representatives of the Pre-RD AOC Group and EPA by the PDI Project Coordinator.

3.3 Coordination with EPA

The PDI Project Coordinator will notify the EPA Project Manager 1 to 2 weeks prior to beginning any field activities so that EPA can schedule any oversight activities required. The PDI Project Coordinator will also notify the EPA Project Manager once field activities have been completed.

Split samples for chemical analyses can be provided to EPA upon its request. EPA's Project Manager should contact the PDI Project Coordinator to coordinate this activity and determine appropriate logistics. If EPA elects to collect split samples, collection at stations where blind field duplicates are taken is recommended so that EPA's comparison samples can be evaluated relative to the field and analytical variability measured by the project team.

4. SAMPLE COLLECTION PROCEDURES

The following sections describe the procedures and methods that will be used during subsurface sediment sampling in accordance with the project QAPP, and previously approved FSPs and SOPs from the RI for methods. These procedures include health and safety procedures, sampling methods; recordkeeping; sample handling, storage, and shipping; and field quality control. All field sampling activies will follow procedures outlined in the project Health and Safety Plan (AECOM and Geosyntec 2018c).

4.1 Sampling Vessels and Equipment

Gravity will provide vessels and a Vibratory Core Tube Driver (vibracore) system to conduct subsurface sediment coring. Vibracore tubes will be advanced to various lengths as discussed in Section 2.2.2. Vibracore tubes will be sectioned on the vessel platform into transportable sizes (approximately 4 ft) and transported by vehicle to the AECOM Sample Processing Facility for processing. Core tubes will be kept upright to the extent practicable until processing.

Gravity will perform the coring activities utilizing two sampling vessels, R/V *Cayuse* and R/V *Tieton*, each vessel equipped with a RIC-5500 vibracore system. Both vessels contain a virtual anchoring system that incorporates autopilot and two small motors to keep the vessel on station without needing to set fixed anchors. The R/V *Cayuse* is a 26 ft research vessel with landing craft design, crew cabin, wash-down hose, and working area. The R/V *Tieton* is a 34 ft research vessel with landing craft design and crew cabin, pilot house, and working area. Both vessels have an A-frame with custom research winch and dynamic positioning system. A minimum of 4-inch [in]-diameter Lexan (preferred) or aluminum core tubes and custom core catchers will be used for core collection. Core tubes can be adapted with an internal, mechanical piston-type device to improve core recoveries, if needed. Both of these vessels and their coring equipment have been previously used on the lower Willamette River.

Alternative vessels are available and can provide additional or backup support for in-water sampling as needed. All vessels will be moored within Swan Island Lagoon and mobilized from Swan Island public boat launch.

Additional equipment needed for coring and sample processing equipment are identified on the checklist in Appendix A. Sample containers and preservatives, as well as coolers and packing material, will be supplied by the analytical laboratory.

4.2 Station Positioning and Vertical Control

Station positioning and vertical control will be performed consistent with the RI Round 1 FSP (Integral 2002). A differential global positioning system (DGPS) unit will be used on the vibracore A-frame to confirm the horizontal sampling locations to an accuracy of 1 to 2 meters. The DGPS accuracy will be confirmed each morning and evening to a known land-based survey point. Confirmed stations locations will be recorded to the nearest whole ft in North American Datum (NAD) 1983 Oregon State Plane North datum.

Vertical control will be established using an on-board fathometer or lead line to measure depth to mudline at core locations at the time of collection. Water depths will be converted to mudline elevations in ft NAVD88 based on the river stage at the time of sampling as recorded at the Morrison Street Bridge located at RM 12.7. The vertical CRD will also be recorded. Water levels will be recorded to the nearest one tenth of a foot in the datum specified in the DQMP (AECOM and Geosyntec 2018b). Further details regarding station positioning and vertical controls are provided in Section 5.2 of Integral (2002).

4.3 Core Collection and Processing

Subsurface core sample collection will be performed as described in the RI Round 2 FSP, Section 4.0 (Integral 2004). In general, coring will follow these steps:

1. Subsurface sediment core collection:
    a. Core tube caps will be removed immediately prior to placement into coring device, in order to minimize potential core contamination.

    b. Position will be recorded when the vibracore first rests on the sediment surface.

    c. The vibracore will be advanced without power (under its own weight), then vibration will be applied until the core tube is advanced to the target depth or refusal.

d. After a brief pause, the core tube will be extracted from the sediment using only the minimum vibratory power needed for extraction.

e. As soon as the core tube daylights to the surface water/air interface, a bottom cap will be placed over the tube to prevent material loss out of the core catcher.

f. Inspect the exterior side-walls of core tube for signs of potential NAPL and scrapes/scoring of the aluminum walls from contact with dense gravel. If NAPL is suspected, then take appropriate field precautions as described in the RI FSPs and Appendix B.

g. The following core collection data will be recorded on the vessel (in the core collection log [Appendix A]):

   i. Date/Time. Local date and time when the vibracoring began at each station.

   ii. Depth to Mudline. Water depth at the sampling station at the time of core collection.

   iii. Total Drive Length. Core tube length and depth of the core tube penetration into the subsurface.

   iv. Recovered Length. Thickness of the sediment column retained in the core tube prior to sectioning and removal of the core catcher.

   v. Sediment Observation. Average grain size, color, notable odors, debris, etc. observed at each of the cut ends of the core section. Visual description will follow American Society for Testing and Materials (ASTM) visual-soil classification procedure.

h. Core will be accepted, rejected, or stored on the vessel pending another drive attempt. If a core sample does not meet the core acceptance criteria, then field protocols will be followed as described in Section 4.4 of this FSP.

i. After core acceptance, water will be carefully decanted from the top of the core tube to minimize sediment disturbance. Cores will be cut into segments approximately 4 ft long for handling, storage, and transport. Core tubes will be capped with aluminum foil and plastic caps, scribed on the sidewalls with core and segment ID (A, B, C, etc.) and "up" arrow, stored upright with ice, then transferred upright from the sampling vessel to the AECOM Sample Processing Facility, and stored upright in refrigerators until processed.

2. Core Acceptance Criteria: each subsurface sediment core retrieved on deck will be compared to these acceptance criteria:

a. Overlying water is present and the surface is intact.
b. Core has at least 80% recovery versus penetration.
c. Core tube is in good condition (not excessively bent).
d. Core appears representative of surrounding area.
e. Target penetration depth has been achieved (within +/- 2 ft of target).

4.3.1 Contingency Plan for Field Condition Impediments for Collecting Cores:

During the subsurface sediment coring efforts, the field crew may encounter field conditions that preclude collection of acceptable cores at the planned location (e.g., limited access, poor recovery, safety concerns, debris/rock/bedrock causing refusal). No more than three attempts will be made to relocate the core within a 25 ft radius of the planned location.[2] If the first core attempt meets the acceptable criteria, then no additional cores will be collected at that station. If not, the cores from each attempt will be retained until an acceptable core (as defined above) is acquired; if an acceptable core cannot be obtained within a 30 ft radius, then the best of three attempts will be retained and processed. If recovery is poor for all three attempts (< 60% recovery) or the area within 30 ft is inaccessible, then core drives will be attempted from a larger radius (e.g., 50 ft radius) following discussions with the PDI Project Manager. If an acceptable core cannot be obtained from within a 50 ft radius, attempts may be made further from the target location in coordination with EPA.

4.4 Core and Sample Processing

Subsurface sediment core processing at the field lab will follow these steps:

1. The AECOM Sample Processing Facility is at 1116 SE Caruthers Street, Portland, Oregon. The facility is approximately 20 blocks from the field site and will be used as a base for staging work, sample processing, sample/equipment storage, sample packaging and shipping, daily field team meetings, decontamination supplies, and other support needs.
2. Cores will be opened using a table saw, when possible, according to methods described in RI Round 2 FSP (Integral 2004).
3. If a core exhibits evidence of an oily product present, another method for core extraction may be utilized.
4. Sediment cores will be visually described following ASTM visual soil classification procedures. A logging key is provided in Appendix A.

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[2] Distances proposed in this FSP were based on previous sediment project experience in EPA Region 10.

5. If potential NAPL is observed, then a jar sheen test or other device will be used over the suspected NAPL interval to further estimate (qualitatively) the presence of NAPL; see SOP in Appendix B. Appendix B also provides visual descriptors for residual or free-phase NAPL observations.
6. A hand-held field torvane will be used to measure shear strength and pocket penetrometer to measure compressive strength within each sample interval.
7. Subsurface sample intervals will be 2 ft intervals unless lithology indicates otherwise. Minimum interval thickness will be 1 ft. Maximum thickess will be about 3 ft in general accordance with thickness criteria in RI Round 2 FSP (Integral 2004). 3
8. Cores will be photographed and archived per the RI Round 2 FSP (Integral 2004).
9. After the cores have been described and the sample intervals have been determined, sediment will be collected and homogenized within the determined sample interval until uniform in color and texture and placed into appropriate sample containers for laboratory analysis.
10. Headspace screening using a photoionization detector (PID) will be conducted over the core sediment.
11. Core lithology, geotechnical indexes, PID readings, sample IDs, and sample depth intervals will be recorded in the core processing log (Appendix A).

SOPs from the RI will be followed. These SOPs are from Appendix E of the RI FSP for Round 2 (Integral 2004) and are consistent with Appendix D of the RI FSP for Round 3 (Integral 2006). These SOPs include lists of supplies and equipment, equipment decontamination, core collection, subsurface sediment sample processing, chain of custody, and packaging and shipping samples. The SOPs will be available in hard copy and on the project SharePoint site for easy access by the field crews.

4.5 Sample Handling and Transport

Chain-of-custody procedures will be followed as detailed in the RI Round 2 FSP (Integral 2004) Section 4.8. Samples will be stored on ice at 4°C in a field cooler and shipped to appropriate laboratories as detailed in the RI Round 2 FSP (Integral 2004). Sections 4.8.1 and 4.8.2 of the RI Round 2 FSP along with the SOPs in Appendix E of the RI FSP for Round 2 (Integral 2004) and Appendix D of the RI FSP for Round 3 (Integral 2006) provide additional details on custody, storage, and shipping details, respectively. Additional details are provided in Section 4.3 of the QAPP (AECOM and Geosyntec 2018a).

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[3] The RI Round 2 FSP discussed a range of 1 to 4 ft sample thickness. However, a goal of the PDI study is to refine contaminant depths, so in general, target thicknesses are much less than 4 ft (2 ft target).

4.6 Field Logbook and Forms

All field activities will be recorded in a field logbook as outlined in detail in Section 4.3 of the RI Round 2 FSP (Integral 2004). Field forms (Appendix A of this FSP) will be completed as outlined in detail in the RI Round 2 FSP (Integral 2004).

4.7 Decontamination Procedures

Decontamination procedures for all non-dedicated (reusable) sampling equipment (bowls, spoons, etc.) will follow methods detailed in the RI Round 2 FSP Appendix E Sediment Sampling SOP (Integral 2004). This SOP is consistent with the RI Round 3 FSP Appendix D Sediment Sampling SOP (Integral 2006). In summary, non-dedicated sampling equipment decontamination steps will include an initial rinse with vessel river water to dislodge particles, a scrub with brush and Alconox™ or other phosphate-free detergent, and then a rinse with deionized water. Additional rinses with nitric acid or methanol are not anticipated but may be considered based on sample conditions (e.g., excessive oily/tar residue). Rinses using nitric acid or methanol, if used, will be handled and disposed of according to RI Round 2 FSP Appendix F SOP. Sampling spoons and bowls will be covered with aluminum foil until use (dull side down). Gloves will be replaced before and after handling each sample to minimize sample contamination. Core tubes and core cutter heads will be washed in a similar manner.

4.8 Investigation-Derived Waste Disposal

Investigation-derived waste (IDW) disposal will occur as described in the RI Round 1 FSP (Integral 2002, see Section 5.7). In general, any excess water or sediment remaining after processing core collection and sectioning will be returned to the vicinity of the collection site. Any water or sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site before proceeding to the next station. Phosphate-free, detergent-bearing liquid wastes from decontamination of the core sampling equipment will be washed overboard or disposed into the sanitary sewer system. Waste solvent rinses, if needed, will be held in sealed plastic buckets and disposed of into the sanitary sewer.

Tyvek, gloves, paper towels, plastic sheeting, and other waste material generated during sampling will be placed in heavyweight garbage bags or other appropriate containers and placed in normal refuse containers for disposal at a solid waste landfill. Used core tubes will be washed and then recycled. Leftover sediment after core processing, and oily or other potentially contaminated IDW will be placed in appropriate containers, characterized for disposal, and disposed of at an appropriate EPA-approved waste facility.

4.9 Field Quality Control

Field QC samples are collected to assess variability within samples (e.g., duplicates), to evaluate if potential sources of sample contamination are present (e.g., rinsate and trip blanks), or to confirm proper storage conditions of samples (e.g., temperature blanks). All QA/QC procedures are detailed in the QAPP. Requirements for field QC samples are provided in Table 4, and a summary of all field QC sample numbers is provided in Table 5. Blind field duplicates and other field QC samples, such as trip blanks, temperature blanks, and rinsate blanks, will be collected as outlined in Section 4.6.1 of the QAPP. Rinsate blanks will be collected by pouring deionized water over the sampling spoons and core tubes after field decontamination. Rinsate blanks will be collected for each sampling vessel.

5. LABORATORY ANALYSIS

Subsurface sediment core samples will be sent to the following laboratories for physical and chemical analysis:

- ALS in Kelso, Washington, for PAHs and DDx
- TestAmerica in:
    - Fife, Washington, for PCB Aroclors, TOC, grain size, and total solids (and Atterberg Limits if selected)
    - Sacramento, California, for D/F

Field parameters (measured at the Sample Processing Facility) will include geotechnical index testing down the length of the core at about 2 ft intervals. Measurement tools will include a hand-held field torvane to measure shear strength and pocket penetrometer to measure strength.

Additional details on the analytical methods, QA/QC requirements and procedures, and laboratory specific QA/QC requirements are detailed in Section 4.6 of the QAPP. All samples will be placed in laboratory-supplied sample containers and preserved according to analytical protocols. Sample containers, analytical methods, preservation requirements, holding times, and sample sizes are provided for all analyses in Table 6.

6. DATA MANAGEMENT AND REPORTING

6.1 Field Data Management

The procedures and activities outlined in this FSP are designed to ensure data quality objectives are met. As detailed in the QAPP, the following data management procedures will be performed in the field:

- All samples will be given a unique identifier (Section 2.2 of this FSP).
- All samples will be collected and transported under chain-of-custody control (Section 4.5 of this FSP).
- Field logbooks and data sheets will be maintained (Section 4.6 of this FSP).

- Field QA/QC samples will be collected according to the QAPP (Section 4.9 of this FSP).

6.2 Post-Analysis Data Management and Reporting

Analytical laboratories will be required to adhere to all QA/QC procedures outlined in the QAPP. Laboratories will provide all data for field investigations in electronic format and QA/QC reports, including a narrative of the standard QA/QC protocols. Data validation and data management will be performed according to the QAPP and DQMP. Following data validation, all data, supplementary information, and validator qualifiers will be compiled into an SQL Server database for the project. Data summary files will be provided to EPA as they become available after data validation and database management.

Results from the implementation of this FSP will be used to support the data use objectives described in Section 1.3 of the PDI Work Plan (Geosyntec 2017: Table 5). Data summaries and evaluations will be included in the PDI Evaluation Report.

7. REFERENCES

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TABLES

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	Additional Rationale
Deep Cores (N=60) (New Core Stations and Reoccupy Old Core Stations)										
RM 2E	1	4	PDI-SC-S004	X			Refine horizontal extent - north end	15	8	Better define horizontal gradient extent towards the north end (cores to the north do not tag bottom).
	2	7	PDI-SC-S007		X	C011-2	Refine vertical extent, unbounded to 10 ft bml	15	2	Reoccupy C011-2, which remains unbounded at depth with a concentration of 8,200 ug/kg PCB. Samples in proximity (C011-1, RB13, and C602) are all unbounded.
	3	9	PDI-SC-S009	X			Refine vertical and horizontal extent - southwest end	10	5	C604 is unbounded in vertical direction with a concentration of PCB between 75 and 200 ug/kg.
	4	10	PDI-SC-S010		X	C019-2	Refine vertical extent, unbounded to 15 ft bml	20	2	Reoccupy C019-2, which remains vertically unbounded with a concentration of 1,100 ug/kg PCB. Samples in proximity (C019-1, LWMC1, and C604) are all unbounded.
	5	11	PDI-SC-011	X			Refine horizontal and vertical extent	15	8	Better define horizontal gradient extent. No cores within 250 ft and nearby cores C020, C022, and C025-2 are vertically unbounded.
	6	15	PDI-SC-S015	X			Refine horizontal extent - southwest end	15	8	Better define horizontal towards the Navigation Channel. C605 did not tag bottom and had PCB concentration between 75 and 200 ug/kg.
RM 2.75E	7	19	PDI-SC-S019	X			Data at depth	15	8	No existing core in the dredge footprint. Nearby core C061, unbounded.
RM 3.5E	8	23	PDI-SC-S023		X	C062	Vertical extent, unbounded to 10 ft bml	15	2	No existing core in the dredge footprint.
RM 3.8E (International Slip)	9	24	PDI-SC-S024	X			Refine horizontal extent	15	8	Improve concentration gradient. Spacing between cores +300ft.
	10	28	PDI-SC-S028	X			Refine horizontal extent	15	8	Improve concentration gradient between cores; vertical extent is different between them; spacing between cores +400 ft.
	11	30	PDI-SC-S030		X	LWMC3	Refine vertical extent in Alt F dredge footprint	15	2	LWMC3 unbound vertically with a concentation of PCB at 5,000 ug/kg for the entire core depth of 10 ft bml.
	12	31	PDI-SC-S031	X			Refine horizontal and vertical extent	15	8	Better refine horizontal and vertical extent of remediation area. Nearby grab SED11 had a PCB concentration of 2,000 ug/kg and nearby core C094 had a concentration of 2,100 ug/kg.
	13	32	PDI-SC-S032	X			Riverbank shallow core	15	8	Closest sample SED14 is vertically unbounded. Sample approximately 3 ft bml with a concentration of 1,100 ug/kg. Refine horizontal extent between cap and dredge.
RM3.9W	14	39	PDI-SC-S039	X			Refine horizontal and vertical extent			No historical cores in proposed dredge area.
RM 4W to 5W	15	53	PDI-SC-S053	X			Refine horizontal and vertical extent	15	8	Closest core is unbounded C626. Additionally, no historical cores in proposed dredge area.
RM 4.5E		-		No cores needed, ample amount of data and all shallow exceedances, Alt F dredge						
RM 4.51E	16	55	PDI-SC-S055		X	HC-S-42	Refine vertical extent	10	2	Reoccupy HC-S-42, which was vertically unbounded, core driven ~5 ft bml with a PAH concentration of 220,000 ug/kg. Help refine horizontal extent in nearshore area.
RM 4.52E		-		No cores needed, ample amount of data and all shallow exceedances, Alt F dredge						
RM 4W to 5W	17	62	PDI-SC-S062		X	C136	Refine vertical extent	15	2	Reoccupy C136, which is vertically unbounded, core driven ~15 ft bml with a PAH concentration of 80,000 ug/kg. No other core in existing dredge footprint.
	18	65	PDI-SC-S065		X	C147	Refine vertical extent	15	2	Reoccupy C147, which is vertically unbounded, core driven ~15 ft bml with a PAH concentration of 250,000 ug/kg.
	19	70	PDI-SC-S070		X	C179	Refine vertical extent	15	2	Reoccupy C179, which is vertically unbounded, core driven ~10 ft bml with a PAH concentration of 90,000 ug/kg. Next to C182, also unbounded vertically with a concentration of ~25,000 ug/kg.
RM 5 to 6	20	83	PDI-SC-S083	X			Refine vertical/horizontal extent	15	8	Nearby historical core C221 Did not tag bottom and had a total PAH concentration >68,900 ug/kg.
	21	86	PDI-SC-S086	X				15	8	Nearby historical core PH15-13 did not tag bottom and had a total PAH concentration >85,700 ug/kg.

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	Additional Rationale
RM 5.5E	22	85	PDI-SC-S085	X			No existing cores in dredge footprint	15	8	No existing cores in dredge footprint, one core nearby vertically bounded at 10 ft bml; Alt F dredge/cap.
	23	88	PDI-SC-S088	X				15	8	No existing cores in dredge footprint, one core nearby vertically bounded at 10 ft bml; Alt F dredge/cap.
	24	92	PDI-SC-S092	X				15	8	No existing cores in dredge footprint, one core nearby vertically bounded at 10 ft bml; Alt F dredge/cap.
RM 6W	25	98	PDI-SC-S098	X			Define vertical extent	15	8	Horizontally define Navigation Channel. Need core to define vertical extent. CS003 was less than 1 foot bml, with a concentration of 34,800 ug/kg. Also refine Navigation Channel extent.
	26	103	PDI-SC-S103	X			Horizontal delineation along Navigation Channel, also refine vertical extent for proximal cores	15	8	Horizontally define Navigation Channel. No core currently within proposed dredge footprint.
	27	109	PDI-SC-S109	X				15	8	Refine concentration gradient towards Navigation Channel and at depth. Closest cores ~250 ft away DGS-08C (in Navigation Channel, PAH concentration of 1,800,000 ug/kg). Downriver of LWMC11, unbounded sample with a PAH concentration of 8,400,000 ug/kg and DGS-19SC with a PAH concentration of 4,500,000 ug/kg.
	28	108	PDI-SC-S108		X	C244	Define vertical extent	15	2	Reoccupy C244 which is vertically unbounded, core driven ~10 ft bml with a PCB concentration of 250 ug/kg. Southern edge of proposed dredge footprint.
	29	113	PDI-SC-S113		X	C258	Refine vertical extent	15	2	Reoccupy C258 which is vertically unbounded to ~10 ft bml with a PAH concentration of 290,000 ug/kg.
RM 6.8E	30	131	PDI-SC-S131	X			Refine vertical/horizontal extent in the low spot near C291	15	8	Distance between cores is greater than 300 ft. Two of the four closest cores are unbounded vertically with PCB concentrations of 250 ug/kg and 750 ug/kg.
RM 7E	31	144	PDI-SC-S144	x			Refine horizontal and vertical extent	15	8	Proposed dredge area with historical cores greater than 250 ft away.
RM 7W	32	136	PDI-SC-S136	X			Refine vertical extent	15	8	Proposed dredge area around C311, DGS-37SC, SD072, and C316 cores are all vertically unbounded and have PAH concentrations >50,000 ug/kg and up to 570,000 ug/kg.
	33	139	PDI-SC-S139	X			Refine vertical extent	15	8	Proposed dredge area around WB-66 is unbounded vertically and horizontally and has 2,3,7,8-TCDD concentrations up to 0.0015 ug/kg.
	34	146	PDI-SC-S146	X			Define vertical extent	15	8	Proposed dredge area around C679 is unbounded vertically and has a 2,3,7,8-TCDD concentration of 0.003 ug/kg.
	35	150	PDI-SC-S150	X			Define vertical extent	15	8	Proposed dredge area around LWMC14 is unbounded vertically and has a 2,3,7,8-TCDD concentration of 0.002 ug/kg. Surrounding unbounded samples are WB-37, WB-41, and SD092 with concentrations up to 0.007 ug/kg.
	36	151	PDI-SC-S151	X			Define vertical extent	15	8	Proposed dredge area south of WB-34. WB-34 is unbounded vertically and has a 2,3,7,8-TCDD concentration of 0.001ug/kg.
	37	155	PDI-SC-S155	X			Define extent	15	8	No historical cores within proposed dredge footprint.
RM 7W to 8W	38	157	PDI-SC-S157		X	C690	Refine vertical extent	20	2	Proposed dredge area with no historical cores.
	39	163	PDI-SC-S163	X			Inside pier has no cores	15	8	Inside proposed dredge area has no core samples.
RM 8E to 9E (Swan Island Lagoon)	40	172	PDI-SC-S172	X			Refine vertical extent	15	8	Area between C372 and PSY18C (cores are over 400 ft apart) had PCB concentrations of ~200 ug/kg and >500 ug/kg, respectively. C372 is unbounded vertically.
	41	176	PDI-SC-S176	X			Refine vertical extent	15	8	Define vertical extent between C702 and C703. Additionally, provide additional coverage near pier area where there are limited historical cores.
	42	178	PDI-SC-S178	X			Refine vertical extent	15	8	Area between C364 and PSY20C (cores are over 600 ft apart) had max a PCB concentration of >250 ug/kg and 2,300 ug/kg, respectively.
	43	191	PDI-SC-S191	X			Refine vertical extent	15	8	Proposed dredge area SD133 was unbounded vertically and had a PCB concentration of 2,400 ug/kg.
	44	198	PDI-SC-S198	X			Refine vertical extent	15	8	Better refine vertical gradient between C379 and PSY11C (cores are over 600 ft apart) and had a max PCB concentration of >750 ug/kg and >7.5 ug/kg, respectively.

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	Additional Rationale
	45	203	PDI-SC-S203	X			Refine horizontal extent	15	8	Limited horizontal cores within proposed Swan Island Lagoon dredge footprint.
	46	213	PDI-SC-S213	X			Refine horizontal/vertical extent	15	8	Gradient near C397 (cores up and down river are over 250 ft apart). C397 is vertically unbounded and had a max PCB concentration of >500 ug/kg.
	47	229	PDI-SC-S229		X	C421	Refine vertical extent	15	2	Only one core within pier area and over 200 ft to nearest sample location.
	48	230	PDI-SC-S230	X			Refine vertical extent	15	8	C405 and SD141 (cores are over 300 ft apart) and both are vertically unbounded. The max PCB concentration between the two cores was >500 ug/kg.
	49	238	PDI-SC-S238	X			Refine horizontal and vertical extent	15	8	Cores are over 250 ft apart and vertically unbounded.
RM9.1E	50	228	PDI-SC-S228	X			Refine horizontal and vertical extent			No historical cores in proposed dredge footprint.
RM 8W to 8.5W	51	218	PDI-SC-S218	X			Collect bank sample near C431	15	8	Proposed dredge area north east of C431, edge of dredge area is over 300 ft from nearest C431 core.
	52	221	PDI-SC-S221		X	C450	Refne vertical extent	15	2	Proposed dredge area around C450 is unbounded vertically to 10 ft bml and has a PCB concentration of 2,200 ug/kg.
RM 8.75W	53	222	PDI-SC-S222	X			Refine vertical extent	15	8	Area west of C455; C455 has a max PCB concentration of 6,000 ug/kg.
	54	226	PDI-SC-S226	X			Refine vertical extent	15	8	Proposed dredge area around LWMC19 is unbounded vertically and has a PCB concentration of 2,200 ug/kg.
RM 9.8W	55	248	PDI-SC-S248	X			Define horizontal/vertical extent	15	8	No historical cores within proposed dredge footprint.
	56	254	PDI-SC-S254	X			Cores are vertically unbounded, but there is 10 ft of clean overburden	15	8	Proposed dredge area north east of C738 and C739; both cores are vertically and horizontally unbounded with max concentrations >500 ug/kg of PCB.
	57	255	PDI-SC-S255	X			Refine nearshore extent	15	8	Proposed dredge area west of LMWC24. LWMC24 is vertically unbounded with max concentration >750 ug/kg of PCB.
	58	256	PDI-SC-S256		X	LWMC24	Refine vertical extent, unbounded to 10 ft bml	15	2	LMWC24 is unbounded vertically with a max PCB concentration >750 ug/kg and southward is more than 400 ft from shoreline, no nearshore cores.
	59	257	PDI-SC-S257	X			Cores are vertically unbounded, but there is 10 ft of clean overburden	15	8	Gradient between C739 and LWMC24; both cores are vertically unbounded, with max concentrations > 500 ug/kg of PCB.
RM10.8E	60	263	PDI-SC-S263	X			Define horizontal/vertical extent	15	8	No historical cores within porposed dredge footprint.
Nearshore Cores (N=30) (shallow cores)										
RM 2E	61	2	PDI-SC-S002	X				6	3	Better define horizontal gradient extent towards the north end. Limited historical core data.
	62	14	PDI-SC-S014	X				6	3	Within a proposed dredge area and no historical core within 250 ft.
RM 3.5E	63	22	PDI-SC-S022	X				6	3	No existing core in proposed dredge footprint.
RM 3.8E (International Slip)	64	33	PDI-SC-S033	X				6	3	High concentration of unbounded cores with PCB concentrations >26,000 ug/kg (C092).
	65	34	PDI-SC-S034	X				6	3	No historical coverage in proposed dredge footprint.
	66	36	PDI-SC-S036	X				6	3	Close to hstorical cores C096 and C099. PCB concentrations range from 1,600 ug/kg to <500 ug/kg.
RM 4E	67	42	PDI-SC-S042	X				6	3	No historical cores within 250 ft.
RM 4.1W	68	45	PDI-SC-S045	X				6	3	Historical core SD017 unbounded to 4 ft depth with a PAH concentration >68,900 ug/kg.
RM 4.52	69	61	PDI-SC-S061	X				6	3	Spatial coverage, near historical cores T4-VC29 and T4-B411-06, which have PCB concentrations of 1,300 ug/kg and >75ug/kg, respectively.
RM 4.9W	70	64	PDI-SC-S064	X				6	3	No historical cores in proposed dredge area.
	71	66	PDI-SC-S066	X				6	3	Spatial coverage. Historical core near proposed area SGP-14 had a PAH concentration of >34,800 ug/kg and historical near core C160 was vertically unbounded to 8 ft depth.

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	Additional Rationale
RM 5.6E	72	82	PDI-SC-S082	X			Better define vertical and horizontal extent in shallow bank areas	6	3	Near historical core C203, was vertically unbounded to 10 ft depth and had a PCB concentration of 2,800 ug/kg and located approximately 230 ft away. Historic core C199 was vertically bounded at 6 feet with a PCB concentration greater than 75 ug/kg to 6 ft and located approximately 200 ft away.
RM 5.7W	73	95	PDI-SC-S095	X				6	3	Near historical core C240 is vertically unbounded to 3 ft depth bml and had a PAH concentration >128,000 ug/kg. Over 200 ft from nearest core.
RM 6.2W	74	105	PDI-SC-S105	X				6	3	Near historical cores SDDC24SB and SDDC25SB, vertically unbounded to 4 ft depth bml with PAH concentrations of 710,000 and 250,000 ug/kg, respectively.
RM 6.2E	75	112	PDI-SC-S112	X				6	3	Proposed dredge area with no historical cores within footprint.
RM 6.5W	76	117	PDI-SC-S117	X				6	3	Spatial coverage. No historical cores within 250 ft in proposed dredge footprint. Nearby historical core C136 has a 2,3,7,8-TCDD concentration >0.0006 ug/kg.
RM 6.7E (Willamette Cove)	77	121	PDI-SC-S121	X				6	3	Proposed dredge with no historical cores within footprint.
RM 6.8W	78	127	PDI-SC-S127	X				6	3	Proposed dredge with no historical cores within footprint.
RM 6.8E (Willamette Cove)	79	129	PDI-SC-S129	X				6	3	Proposed dredge with no historical cores within footprint.
RM 7W	80	140	PDI-SC-S140	X				6	3	Proposed dredge area with no historical cores within 200 ft.
	81	154	PDI-SC-S154	X				6	3	Nearby historical cores contain 2,3,7,8-TCDD concentrations up to 0.004 ug/kg. No shallow bank cores within 500 ft.
RM 8E to 9E (Swan Island Lagoon)	82	185	PDI-SC-S185	X				6	3	Spatial coverage between historical cores C364 and PSY16C which have PCB concentrations of 200 and 750 ug/kg, respectively.
	83	188	PDI-SC-S188	X				6	3	Spatial coverage. Nearby historical cores C392 and PSY30C have PCB concentrations of >750 ug/kg and <50 ug/kg, respectively.
	84	192	PDI-SC-S192	X				6	3	Nearby historical core DMMU1 was vertically unbounded to 10 ft depth with PCB concentration >250 ug/kg.
	85	219	PDI-SC-S219	X				6	3	No historical cores within 250 ft.
RM 8.1W	86	189	PDI-SC-S189	X				6	3	Proposed dredge with no historical cores within dredge footprint. Nearby historical core C431 had a PCB concentration of 1,100 ug/kg.
RM 9W	87	232	PDI-SC-	X				6	3	No historical core in proposed dredge footprint.
	88	245	PDI-SC-S245	X				6	3	Spatial nearshore coverage. Nearby historical core C477 vertically unbounded to 7 ft bml with a PCB concentration >500 ug/kg.
RM 9.6E	89	251	PDI-SC-S251	X				6	3	Proposed dredge location with no historical cores.
RM 10.2	90	260	PDI-SC-S260	X				6	3	Proposed remediation footprint with no historical cores.

Notes:

Deep cores are collocated with an SMA surface sediment grab. There are a total of 60 collocated grabs (44 New Core Locations, 16 Reoccupy Core Locations).
Proposed core stations from RM 11E have been removed. The PDI study will rely on recent data collected within the SMA footprint.
Sample names will include Station ID and depth of sampling interval.

Acronyms:

ug/kg = microgram per kilogram; bml = below mudline; E = east; ft = feet, PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl; PDI = pre-remedial design investigation; PRP = potentially responsible party; RM = river mile; SMA = sediment management area; W = west

Table 2. Summary of Subsurface Sediment Sample Types, Numbers, and Analytes

Subsurface Sediment Core Type / Purpose	No. of Stations	No. of Samples	Analyte List (focused COCs)				
			PCB Aroclors	*PAHs*	*PCDD/F*	*DDx*	*Grain size and TOC*
Deep Core Stations	60	377	X	X	X	X	X
Nearshore (Shallow) Cores	30	90	X	X	X	X	X
Archive 1 ft Interval near bottom of core	TBD	TBD	Archive pending 2 ft results				
Total Count	**90**	**467**					

Notes:

Deep Cores are a combination of New Core Stations and Reoccupy Core Stations which range in depth from 10 to 20 feet.

Sample Collection will occur every 2 feet of depth except for reoccupy core stations.

Reoccupy Core Stations will have two samples collected (one at the historical depth and one 2 feet lower).

All Shallow Bank Core Stations will be to a depth of 6 feet.

Focused COCs include: DDx, PCB Aroclors, PAHs, PCDD/Fs, TOC, and Grain Size.

Acronyms:

COC = contaminant of concern; DDx = sum of dichlorodiphenyltrichloroethane and its derivatives; PAHs = polycyclic aromatic hydrocarbon; PCBs = polychlorinated biphenyls; PCDD/Fs = polychlorinated dibenzo-p-dioxins and furans; TBD = to be determined; TOC = total organic carbon

Table 3. Station Identification Scheme, Mudline Elevations, and Location Coordinates

Station ID	Core Description	Mudline Elevation (CRD - Feet)[a]	Proposed Location Coordinates (NAD 1983; Intl Feet)[b]		Sequential Station Count
			Easting	*Northing*	
PDI-SC-S002	Shallow Core	N/A	7617870	724983	1
PDI-SC-S004	Deep Core	-3.5	7617674	724708	2
PDI-SC-S007	Deep Core	N/A	7617494	724204	3
PDI-SC-S009	Deep Core	-36.1	7617132	723879	4
PDI-SC-S010	Deep Core	-23.9	7617252	723775	5
PDI-SC-S011	Deep Core	-8.5	7617185	723519	6
PDI-SC-S014	Shallow Core	N/A	7617131	723185	7
PDI-SC-S015	Deep Core	-33.0	7616871	722877	8
PDI-SC-S019	Deep Core	-26.8	7616724	721584	9
PDI-SC-S022	Shallow Core	N/A	7617439	718310	10
PDI-SC-S023	Deep Core	-48.7	7617275	717743	11
PDI-SC-S024	Deep Core	-38.7	7618163	717155	12
PDI-SC-S028	Deep Core	-24.5	7619022	717184	13
PDI-SC-S030	Deep Core	-13.6	7619376	717045	14
PDI-SC-S031	Deep Core	-22.4	7619579	717144	15
PDI-SC-S032	Deep Core	-9.2	7619801	717238	16
PDI-SC-S033	Shallow Core	-1.9	7619895	717023	17
PDI-SC-S034	Shallow Core	N/A	7620011	717204	18
PDI-SC-S036	Shallow Core	N/A	7618072	716752	19
PDI-SC-S039	Deep Core	N/A	7616637	715830	20
PDI-SC-S042	Shallow Core	N/A	7618436	715951	21
PDI-SC-S045	Shallow Core	N/A	7617224	714365	22
PDI-SC-S053	Deep Core	N/A	7617469	713721	23
PDI-SC-S055	Deep Core	-9.3	7619660	713673	24
PDI-SC-S061	Shallow Core	N/A	7620462	713053	25
PDI-SC-S062	Deep Core	-12.4	7618175	712584	26
PDI-SC-S064	Shallow Core	N/A	7618256	712076	27
PDI-SC-S065	Deep Core	N/A	7618588	711681	28
PDI-SC-S066	Shallow Core	N/A	7618929	711020	29
PDI-SC-S070	Deep Core	-9.7	7619684	710016	30
PDI-SC-S082	Shallow Core	N/A	7622325	708748	31
PDI-SC-S083	Deep Core	-50.6	7621575	708069	32
PDI-SC-S085	Deep Core	N/A	7622302	708578	33
PDI-SC-S086	Deep Core	-50.8	7621839	707824	34
PDI-SC-S088	Deep Core	-36.9	7622381	708290	35
PDI-SC-S092	Deep Core	N/A	7622708	708151	36
PDI-SC-S095	Shallow Core	-8.6	7622008	707161	37
PDI-SC-S098	Deep Core	-45.6	7622652	706762	38
PDI-SC-S103	Deep Core	-39.8	7623053	706373	39
PDI-SC-S105	Shallow Core	N/A	7623049	706035	40
PDI-SC-S108	Deep Core	-11.3	7623957	706997	41
PDI-SC-S109	Deep Core	-44.6	7623821	706069	42
PDI-SC-S112	Shallow Core	N/A	7624572	706744	43
PDI-SC-S113	Deep Core	-40.5	7624300	705634	44
PDI-SC-S117	Shallow Core	N/A	7624686	705196	45
PDI-SC-S121	Shallow Core	N/A	7625899	706030	46
PDI-SC-S127	Shallow Core	N/A	7625928	704408	47
PDI-SC-S129	Shallow Core	N/A	7626904	705849	48
PDI-SC-S131	Deep Core	-31.6	7626895	705603	49
PDI-SC-S136	Deep Core	N/A	7626539	703726	50
PDI-SC-S139	Deep Core	-7.4	7627058	703342	51
PDI-SC-S140	Shallow Core	N/A	7627140	702977	52
PDI-SC-S144	Deep Core	N/A	7628759	704114	53
PDI-SC-S146	Deep Core	-16.4	7627591	702896	54
PDI-SC-S150	Deep Core	-7.0	7627909	702475	55
PDI-SC-S151	Deep Core	-28.8	7628124	702359	56

Table 3. Station Identification Scheme, Mudline Elevations, and Location Coordinates

Station ID	Core Description	Mudline Elevation (CRD - Feet)[a]	Proposed Location Coordinates (NAD 1983; Intl Feet)[b]		Sequential Station Count
			Easting	*Northing*	
PDI-SC-S154	Shallow Core	N/A	7628333	701890	57
PDI-SC-S155	Deep Core	N/A	7628616	701529	58
PDI-SC-S157	Deep Core	-37.9	7628992	700980	59
PDI-SC-S163	Deep Core	-25.8	7629268	700352	60
PDI-SC-S172	Deep Core	-13.1	7633011	701895	61
PDI-SC-S176	Deep Core	-43.3	7632595	701151	62
PDI-SC-S178	Deep Core	-34.4	7632913	701345	63
PDI-SC-S185	Shallow Core	N/A	7633644	701791	64
PDI-SC-S188	Shallow Core	N/A	7632478	700346	65
PDI-SC-S189	Shallow Core	N/A	7630828	698942	66
PDI-SC-S191	Deep Core	-47.5	7632893	700640	67
PDI-SC-S192	Shallow Core	N/A	7633168	700669	68
PDI-SC-S198	Deep Core	-33.3	7633962	701063	69
PDI-SC-S203	Deep Core	-34.6	7634188	700563	70
PDI-SC-S213	Deep Core	-31.8	7634983	700093	71
PDI-SC-S218	Deep Core	N/A	7633085	696851	72
PDI-SC-S219	Shallow Core	-24.3	7635270	699677	73
PDI-SC-S221	Deep Core	-28.8	7633359	696916	74
PDI-SC-S222	Deep Core	-13.4	7633418	696810	75
PDI-SC-S226	Deep Core	N/A	7633678	696609	76
PDI-SC-S228	Deep Core	-17.1	7635600	697287	77
PDI-SC-S229	Deep Core	N/A	7635857	699177	78
PDI-SC-S230	Deep Core	-23.0	7636127	699520	79
PDI-SC-S232	Shallow Core	N/A	7634221	696225	80
PDI-SC-S238	Deep Core	-14.1	7636448	698736	81
PDI-SC-S245	Shallow Core	N/A	7635255	695640	82
PDI-SC-S248	Deep Core	-20.4	7636288	695194	83
PDI-SC-S251	Shallow Core	N/A	7637607	696102	84
PDI-SC-S254	Deep Core	-23.4	7637333	694600	85
PDI-SC-S255	Deep Core	N/A	7637134	694051	86
PDI-SC-S256	Deep Core	N/A	7637282	694038	87
PDI-SC-S257	Deep Core	-16.8	7637494	694352	88
PDI-SC-S260	Shallow Core	N/A	7639609	692691	89
PDI-SC-S263	Deep Core	N/A	7642066	691479	90

Notes:

Sample names will include Station ID and depth of sampling interval.

Table 4. Field Quality Control Sample Requirements

QA/QC Sample Type	Frequency
Temperature Blanks	1 per cooler
Blind Field Duplicates	1 per 20 samples
Field Equipment Rinsate Blanks	1 per 20 samples or 1 per week

Acronyms:
QA/QC = quality assurance/quality control

Table 5. Summary of Estimated Number of Field Quality Control Samples

Subsurface Sediment Sample Type	No. of Samples	Estimated Number of Field Weeks	Blind Field Duplicates	Field Equipment Rinsate Blanks
Deep Core Stations	377	18.9	19	19
Nearshore (Shallow) Core Stations	90	3.0	5	3
Total Count	**467**	**21.9**	**24**	**22**

Notes:

Estimated number of field weeks for one vessel; two vessels are planned to be in the field.

Blind Field Duplicates will each be collected at a rate of 1 per 20 samples.

Rinsate Blanks will be collected at a rate of 1 per 20 samples or 1 per week or piece of equipment.

Table 6. Analysis Method, Sample Containers, Preservation, Holding Times, and Sample Volume

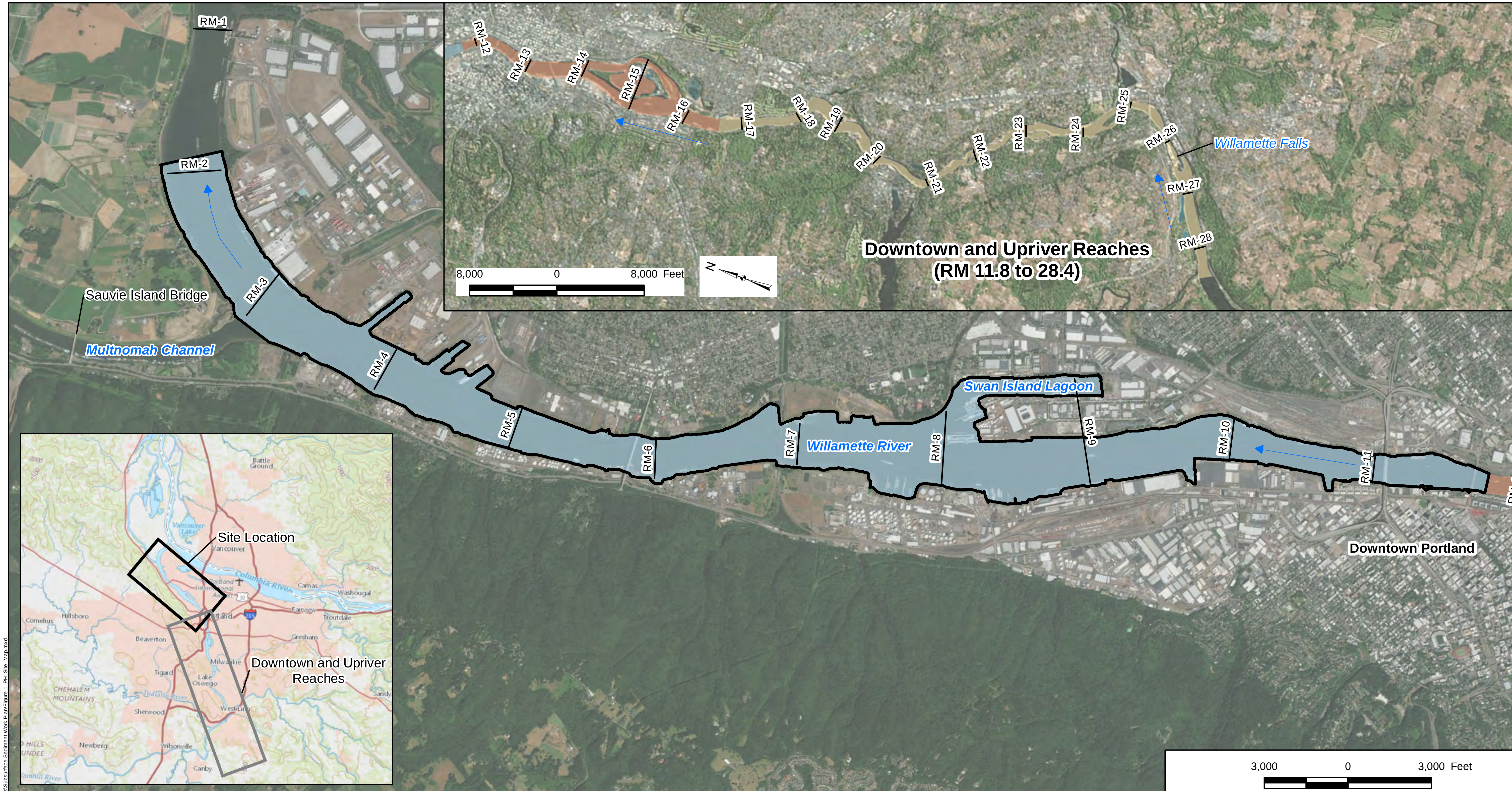
Sediment Parameter	Method	Container		Preservation	Holding Time	Minimum Sample Size (wet weight grams)
		Type	*Size*			
PCBs Aroclors	EPA 8082A	WMG	8 oz	Refrigerate, 4ºC Deep Frozen (-20ºC)	1 year, 1 year	100
PCDD/PCDFs	EPA 1613B	Amber Glass Jar	8 oz	Refrigerate, 4ºC Deep Frozen (-20ºC)	1 year, 1 year [a]	100
PAHs	EPA 8270SIM	WMG	8 oz	Refrigerate, 4ºC Deep Frozen (-20ºC)	14 days, 1 year	100
DDx	EPA 1699M	WMG	8 oz	Refrigerate, 4ºC Deep Frozen (-20ºC)	14 days, 40 days	100
Grain size	ASTM D422	G or P	16 oz	Refrigerate, 4 ± 2ºC	6 months	100 to 150
Total organic carbon	Plumb 1981 / EPA 9060	WMG	4 oz	Refrigerate, 4ºC Deep Frozen (-20ºC)	14 days, 1 year	25

General Notes:
Refrigerate preservation times consistent with PSEP protocols for Washington State.
Frozen preservation times provided from PSEP 1986.
Method detection limits presented in the project QAPP.

Footnotes:
a) stored in darkness

Acronyms:
ºC = degrees Celsius; DDx - sum of dichlorodiphenyltrichloroethane and its derivatives; G = glass; oz = ounce; P = plastic; PAHs - polycyclic aromatic hydrocarbon; PCBs = polychlorinated biphenyls; PCDD/Fs = polychlorinated dibenzo-p-dioxins and furans; PSEP = Puget Sound Estuary Protocol; QAPP = Quality Assurance Project Plan; WMG = wide-mouth glass

FIGURES



Legend

- Flow Direction
- River Mile Marker
- Superfund Site Boundary (RM 1.9 to 11.8)

Study Area

- Site Area (RM 1.9 to 11.8)
- Downtown Reach (RM 11.8 to 16.6)
- Upriver Reach (RM 16.6 to 28.4)

Note:
1. Aerial Imagery provided by ESRI Basemaps 2016

N

Portland Harbor Site Map

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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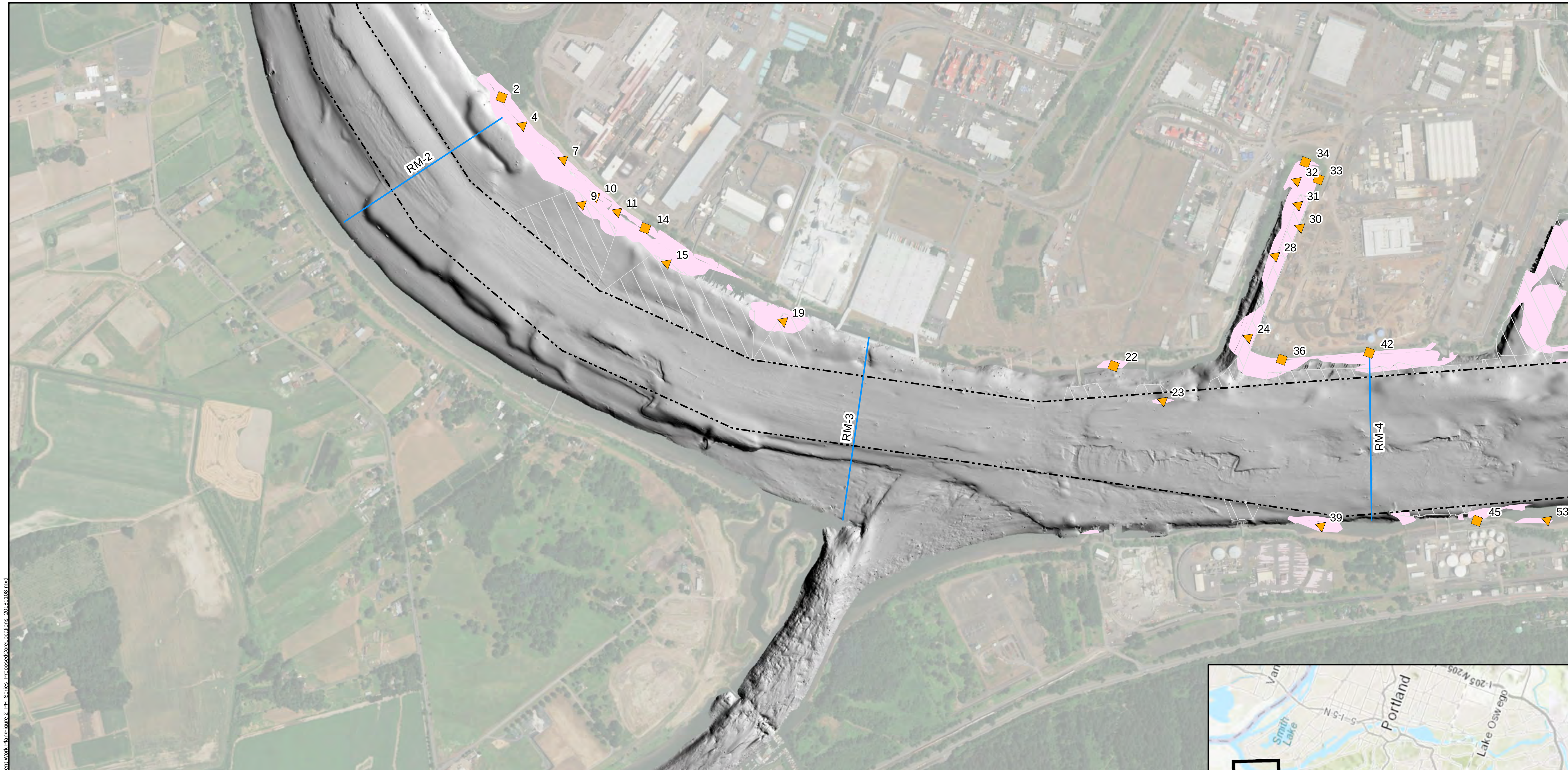
Figure 1

MI/SEA

January 18, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

N

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 1.9 to 4

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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Figure **2a**

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Legend

△	Proposed Deep Core Location (n = 60)
■	Proposed Shallow Core Location (n = 30)
	Alternative F Mod SMA Footprint
	Capped Area (Existing)
	Potential FMD\Berthing Area
	Superfund Site Boundary (RM 1.9-11.8)
	Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

N

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 4 to 6

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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Figure **2b**

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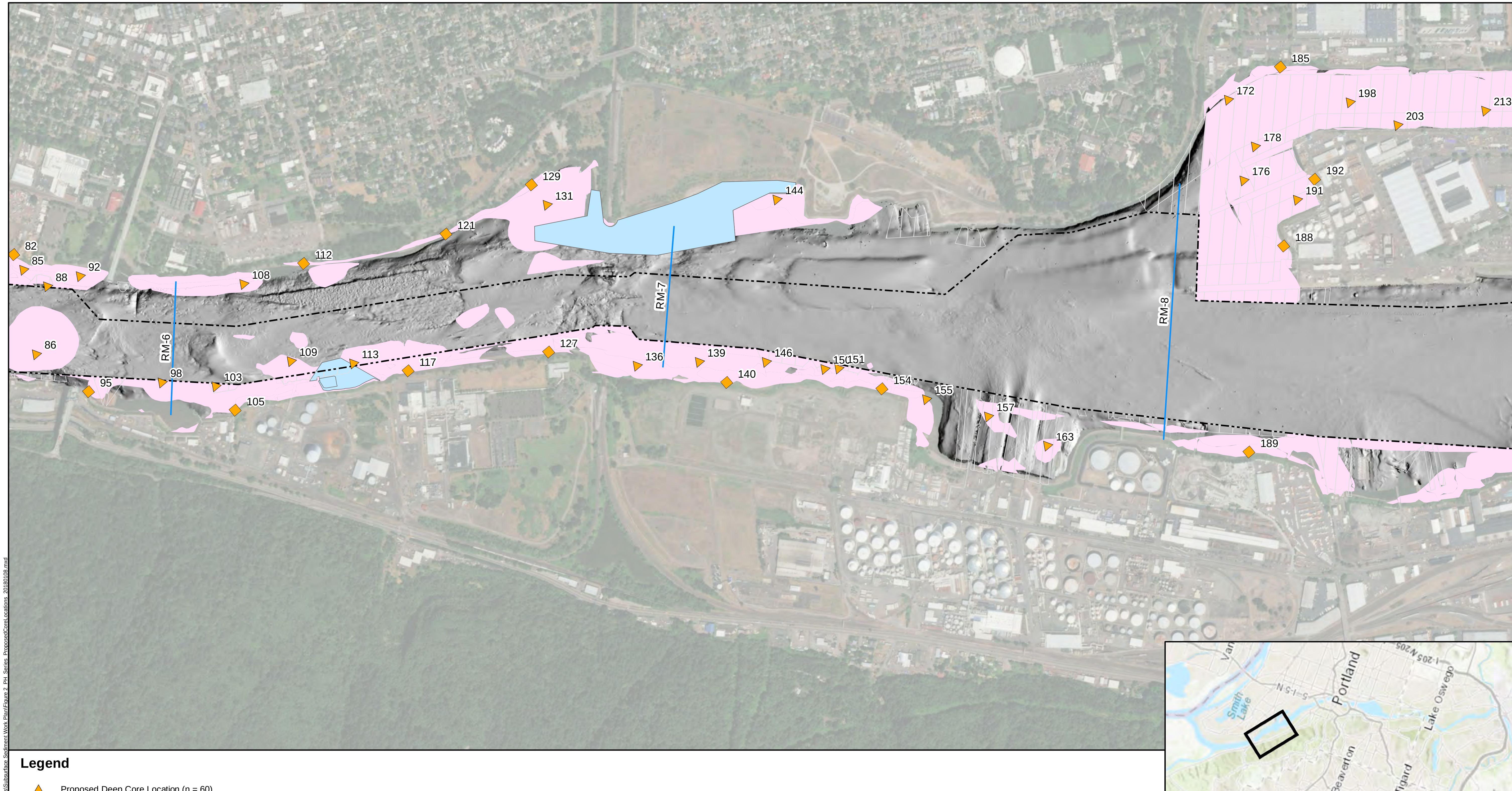

Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

N

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 6 to 8

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PDI Subsurface Sediment Coring FSP

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Figure **2c**

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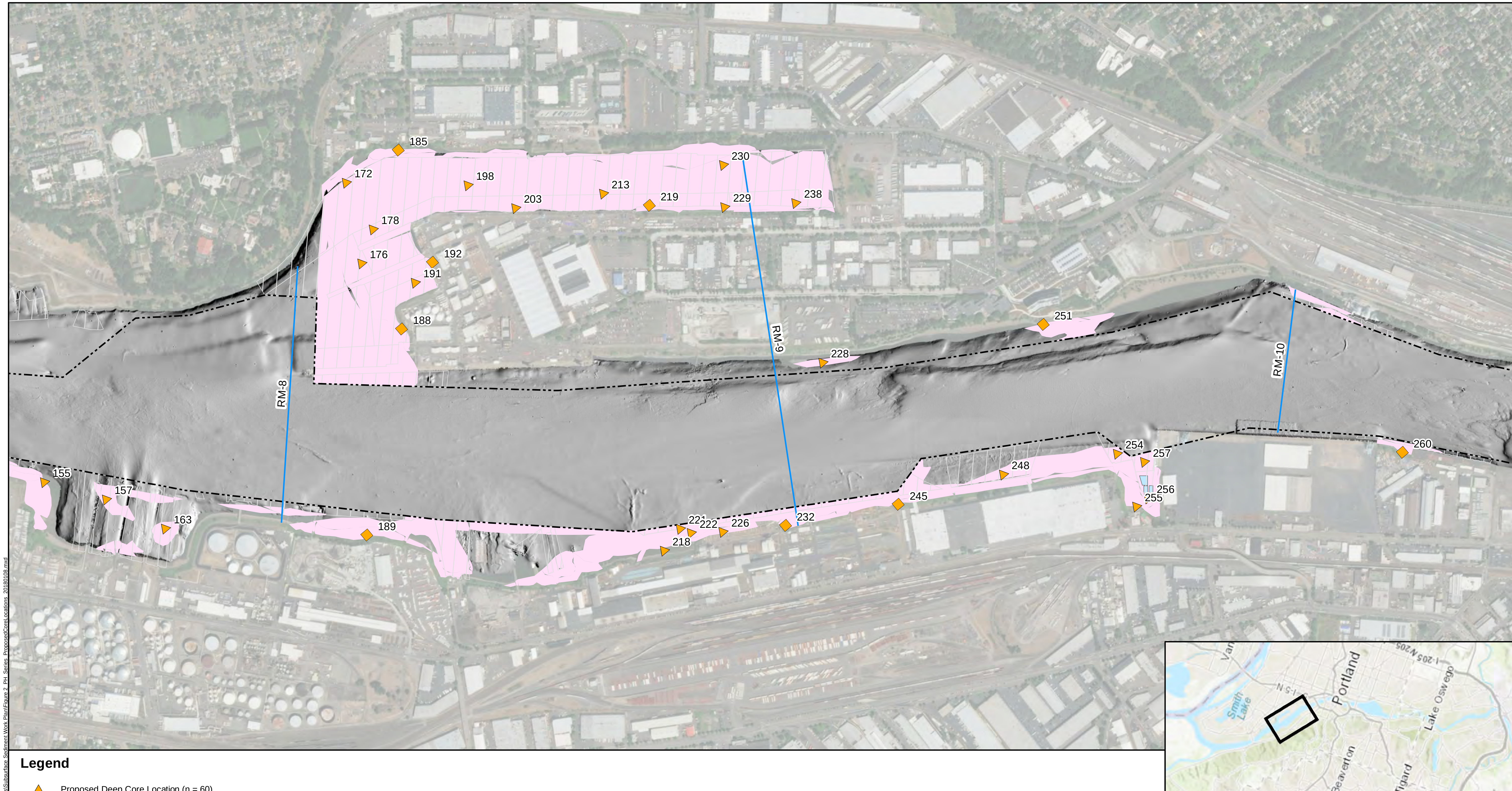

Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 8 to 10

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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Figure **2d**

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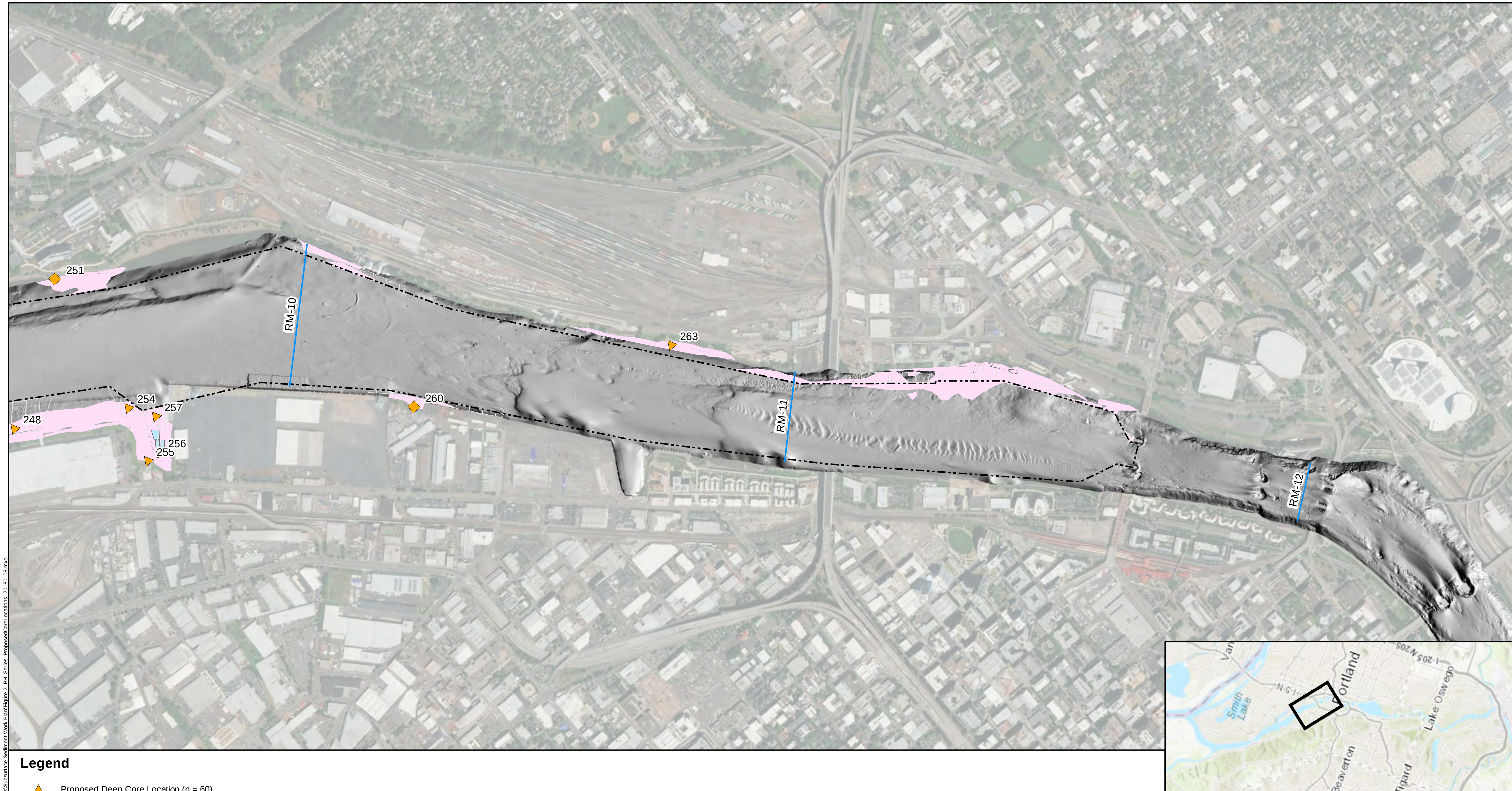

Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 10 to 11.8

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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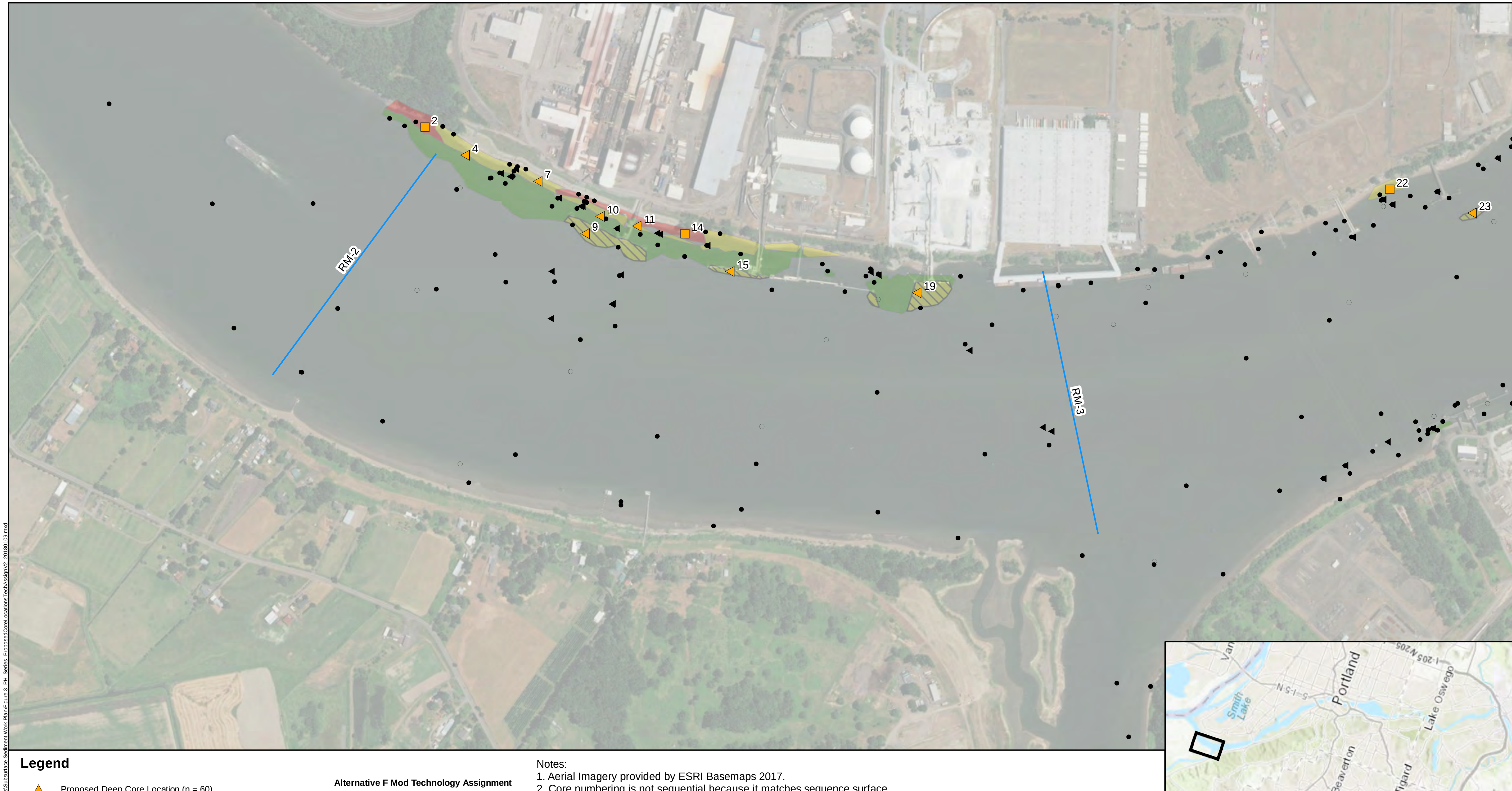
MI/SEA	January 18, 2018	Figure 2e



Legend

- ▲ (orange) Proposed Deep Core Location (n = 60)
- ■ (orange) Proposed Shallow Core Location (n = 30)
- ▲ FS Subsurface Core Location
- ● FS Surface Sediment Sample
- △ Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- ○ Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 1.9 to 3.3

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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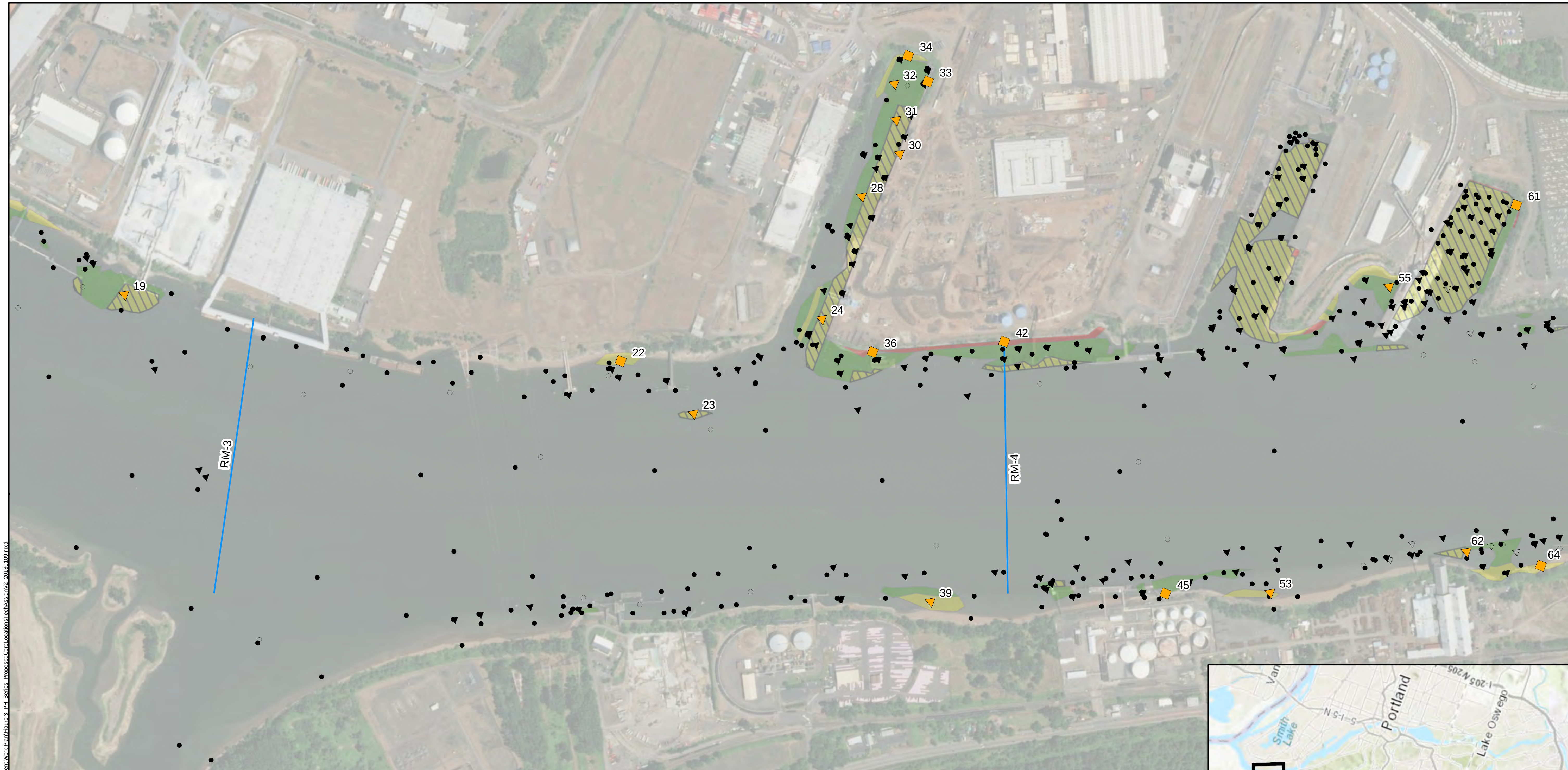
MI/SEA	January 18, 2018	Figure 3a



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 3.3 to 4.2

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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Figure **3b**

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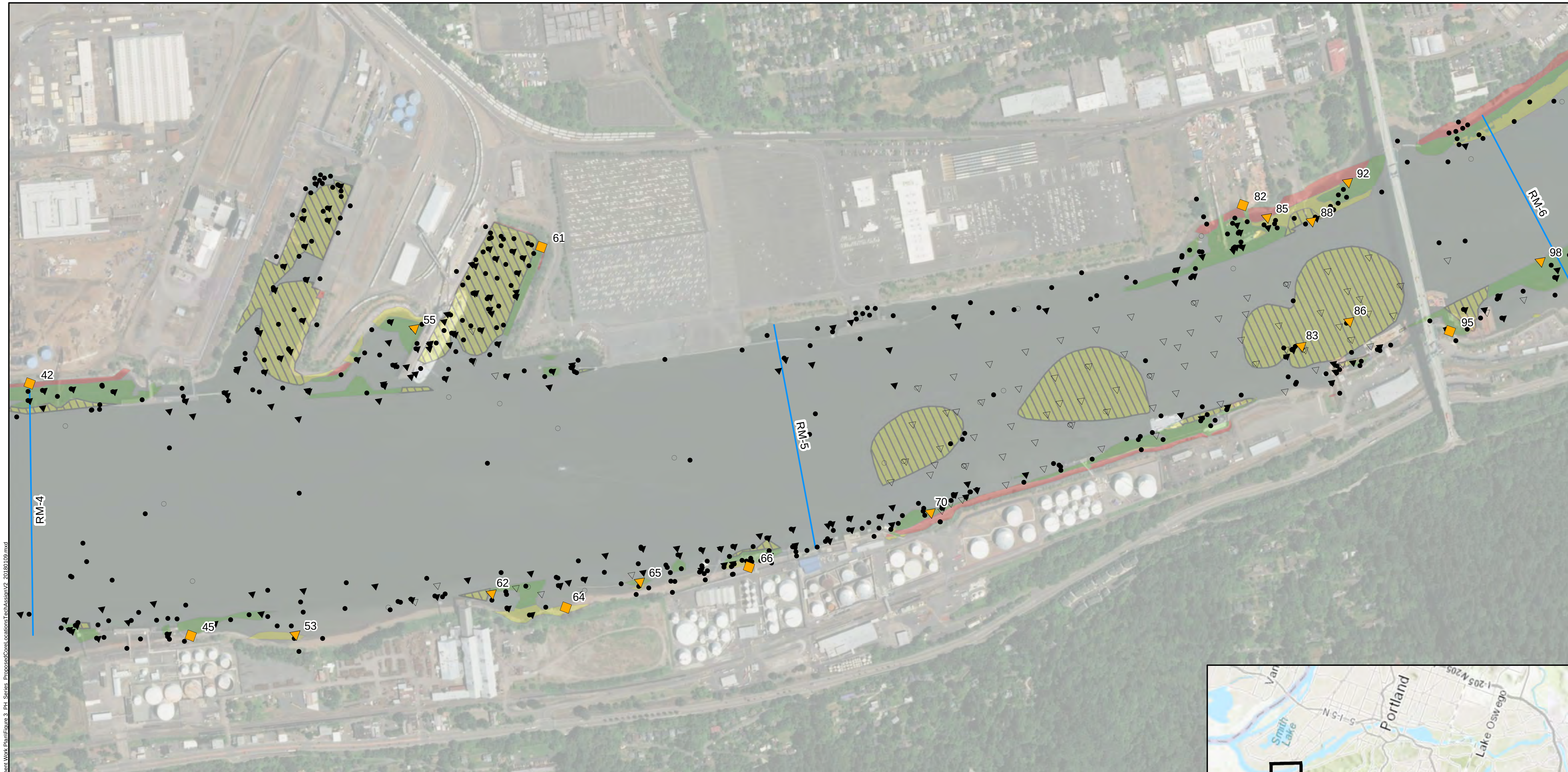

Legend

- ▲ (orange) Proposed Deep Core Location (n = 60)
- ■ (orange) Proposed Shallow Core Location (n = 30)
- ▲ FS Subsurface Core Location
- ● FS Surface Sediment Sample
- △ Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- ○ Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations RM 4.2 to 5.8

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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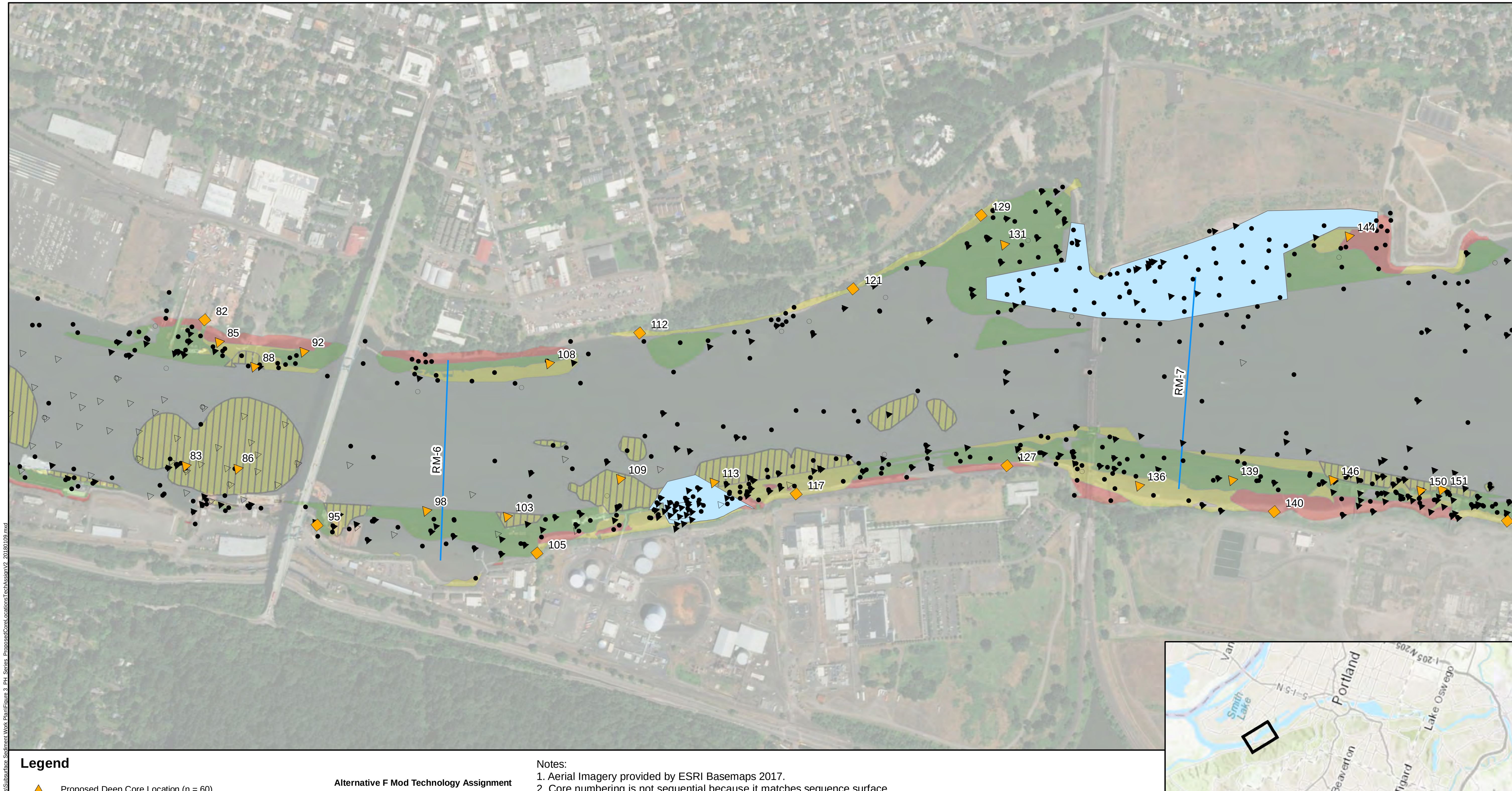
Figure 3c



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 5.8 to 7.0

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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Figure **3d**

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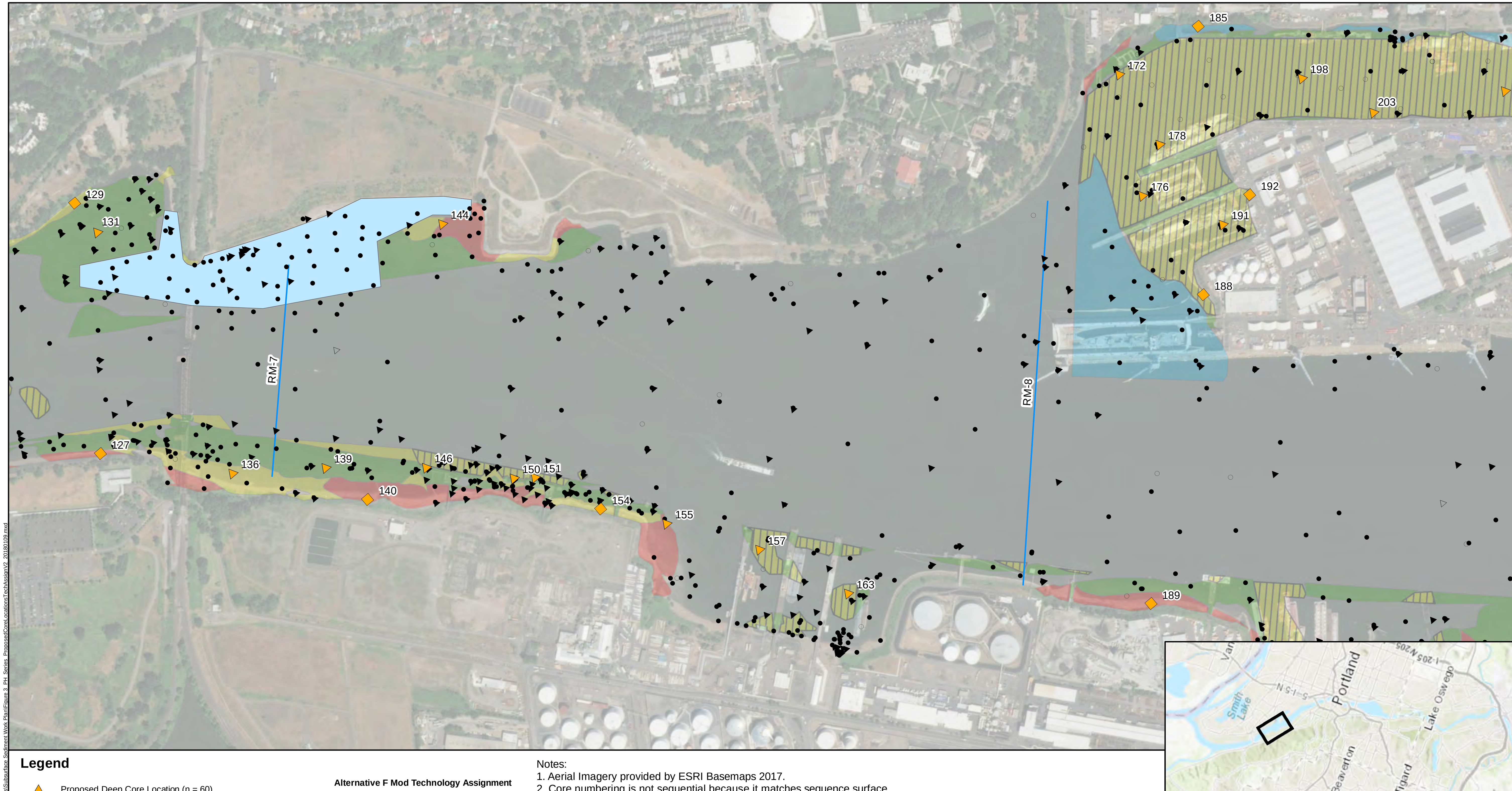

Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations RM 7.0 to 8.2

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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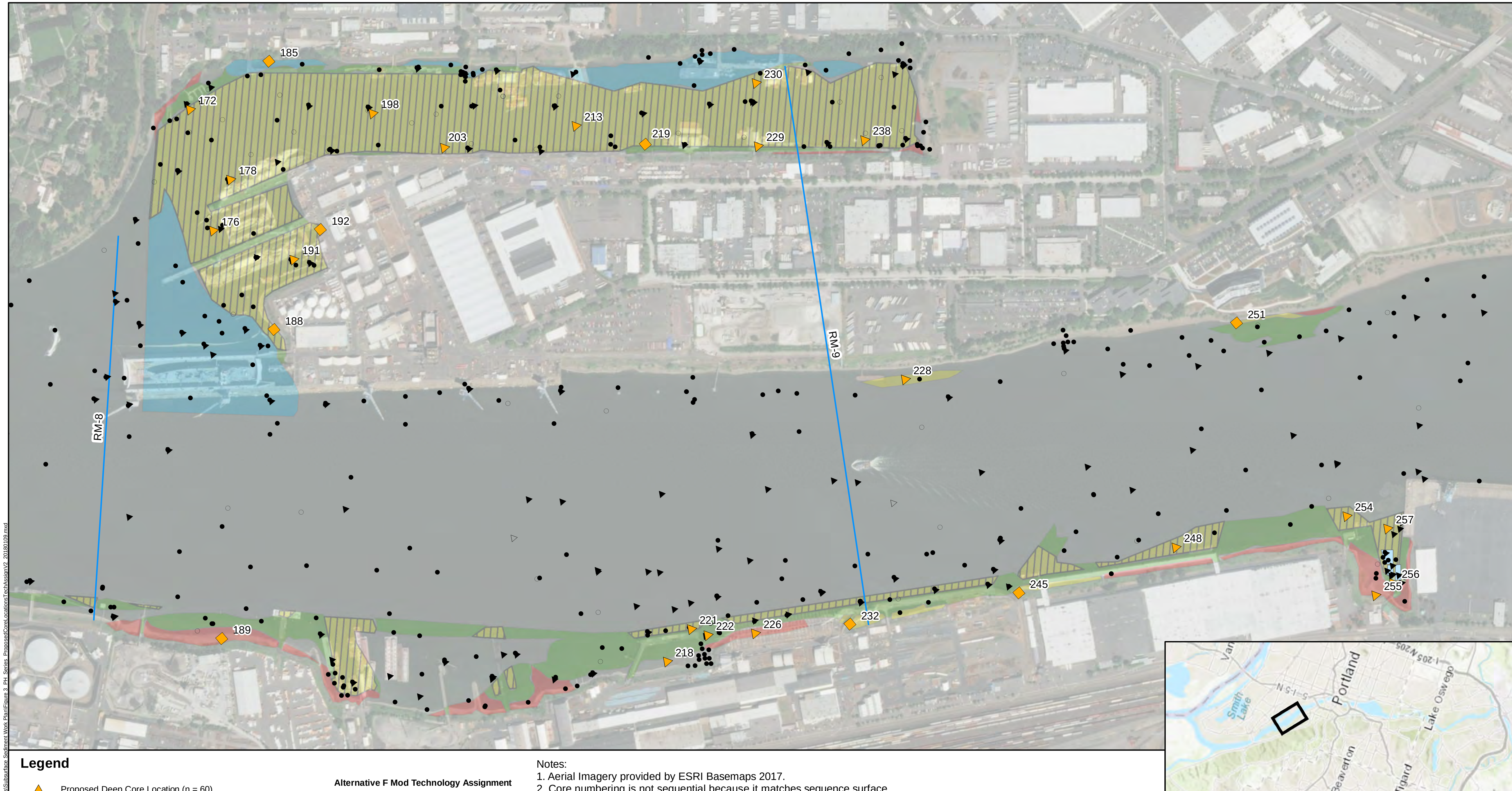
Figure 3e



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations RM 8.2 to 9.5

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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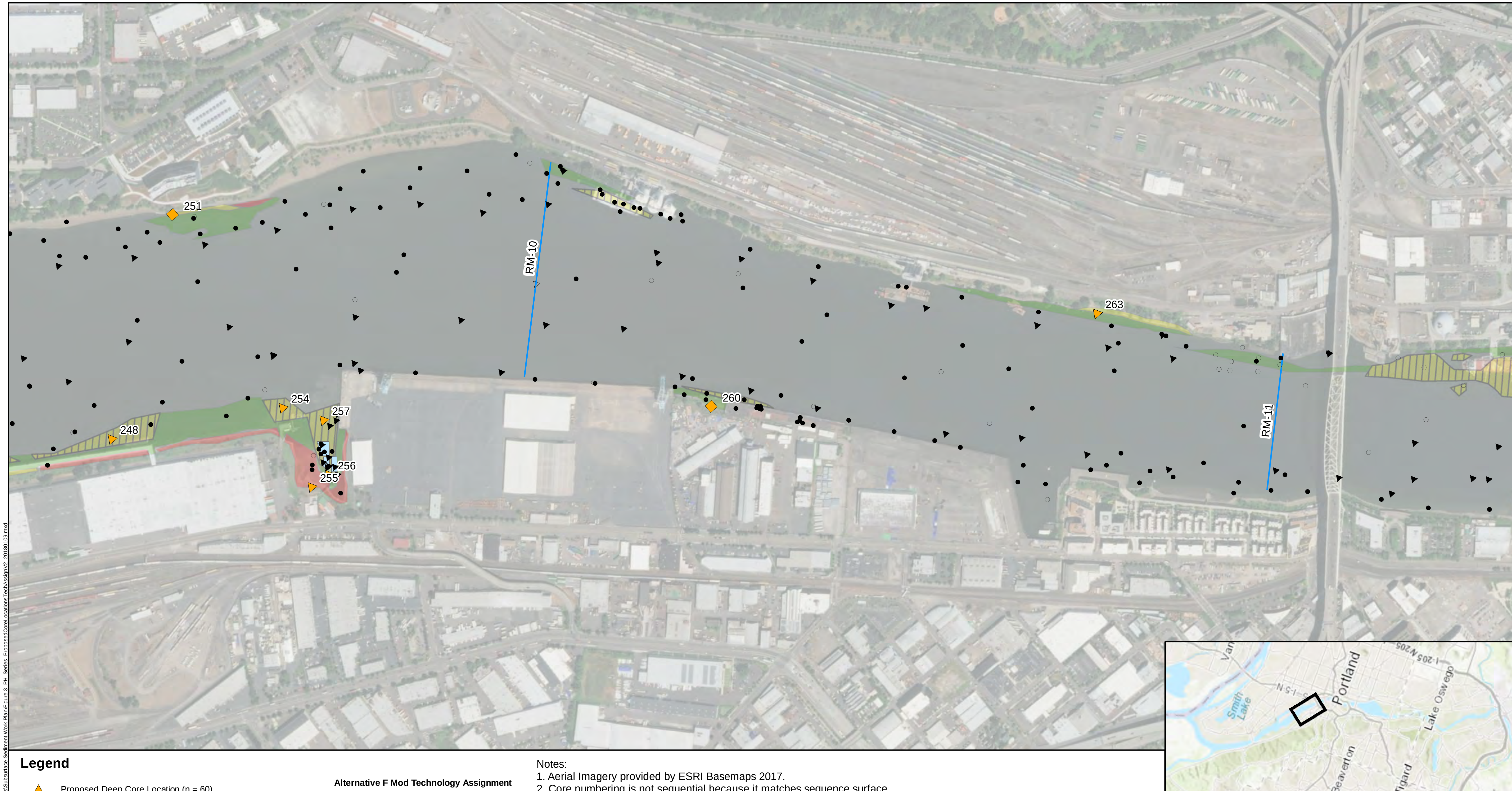
Figure 3f

MI/SEA | January 18, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 9.5 to 10.6

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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Figure **3g**

MI/SEA

January 18, 2018

Legend

- ▲ (orange) Proposed Deep Core Location (n = 60)
- ■ (orange) Proposed Shallow Core Location (n = 30)
- ▲ FS Subsurface Core Location
- • FS Surface Sediment Sample
- △ Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- ○ Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 10.6 to 11.8

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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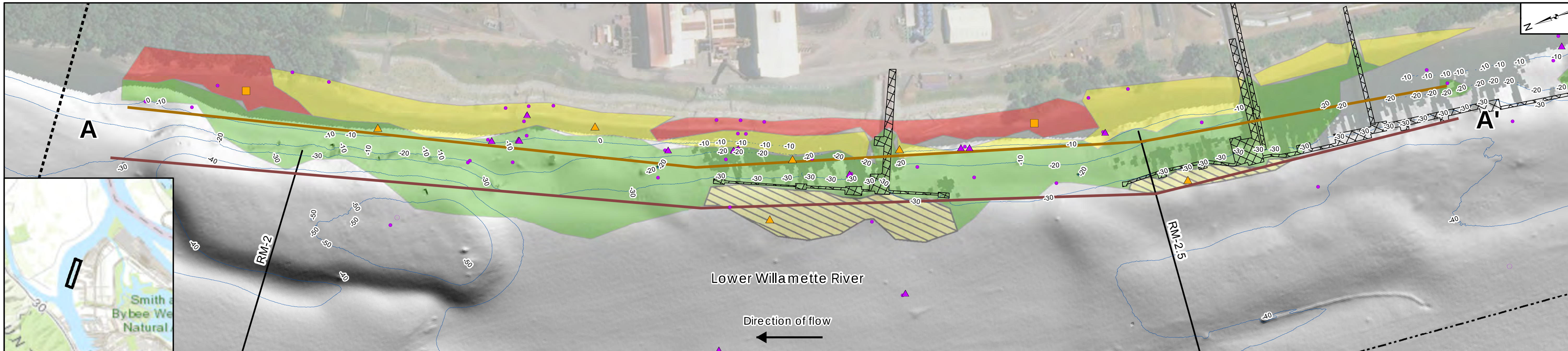
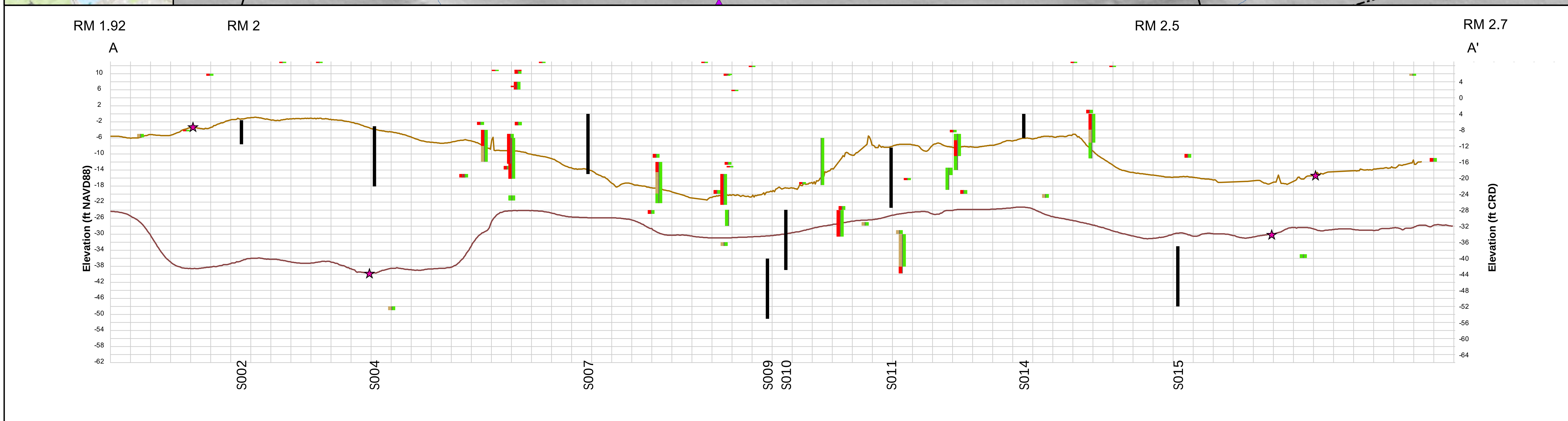
Figure **3h**

MI/SEA | January 18, 2018





Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap

- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker
- Edge of Alt F Mod SMA Footprint

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Shallow Mudline
- Approximate Toe of Slope Mudline
- Proposed Core Location and Grab RI Core Location and Depth

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. Samples and cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88
3. Aerial Imagery provided by ESRI Basemaps 2017.

EPA Record of Decision (ROD) Table 17

Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

10X Vertical Exaggeration

0 200 400 800 Feet

Section A - A'

Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

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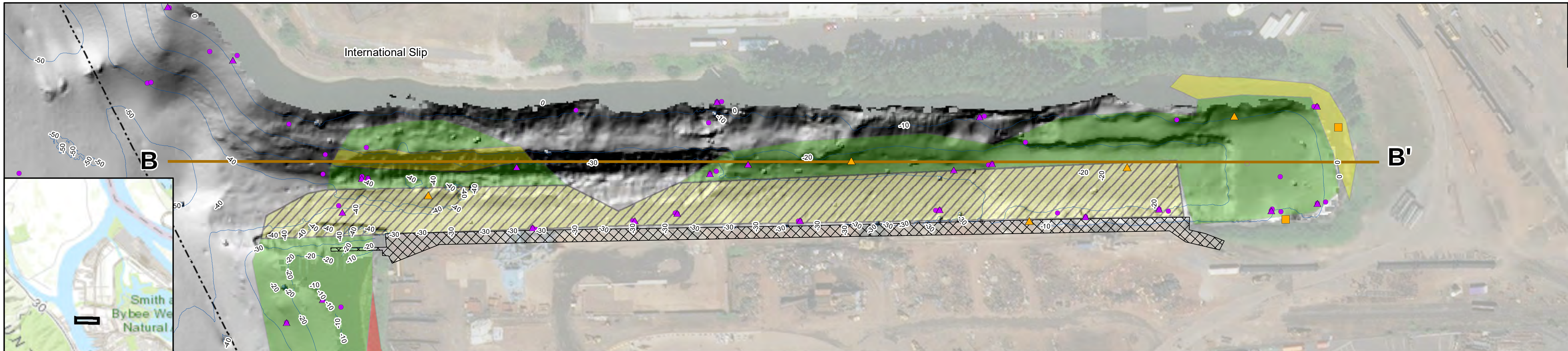
Figure **4a**

SS/JR 18-Jan-2018

Path: P:\GIS\PortlandHarbor\Workplan\GIS\XS\PHSS_XSection_A.mxd



Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap

- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker
- Edge of Alt F Mod SMA Footprint

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Mudline
- Proposed Core Location and Grab RI Core Location and Depth

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. Samples and cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88
3. Aerial Imagery provided by ESRI Basemaps 2017.

EPA Record of Decision (ROD) Table 17

Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

10X Vertical Exaggeration
0 100 200 400 Feet

Section B - B'

Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

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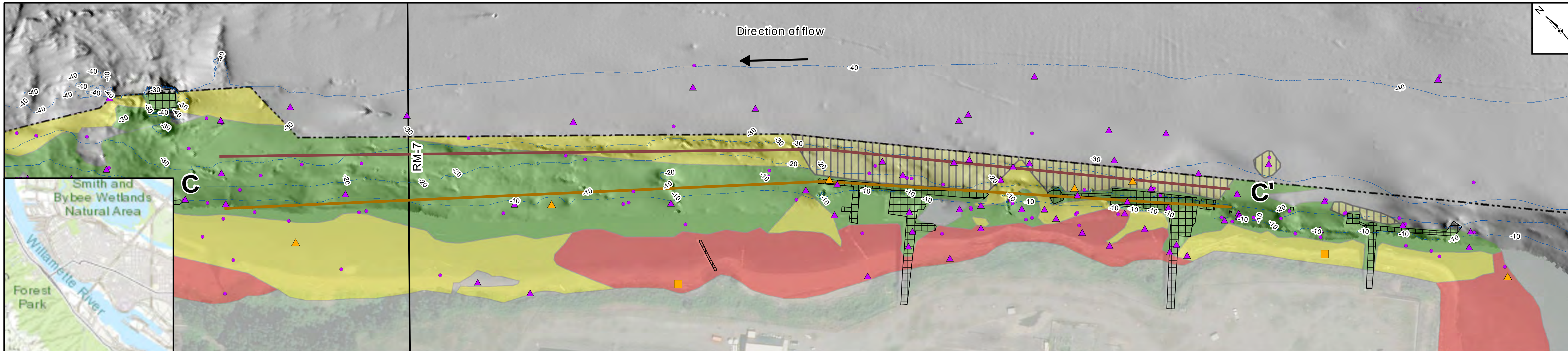
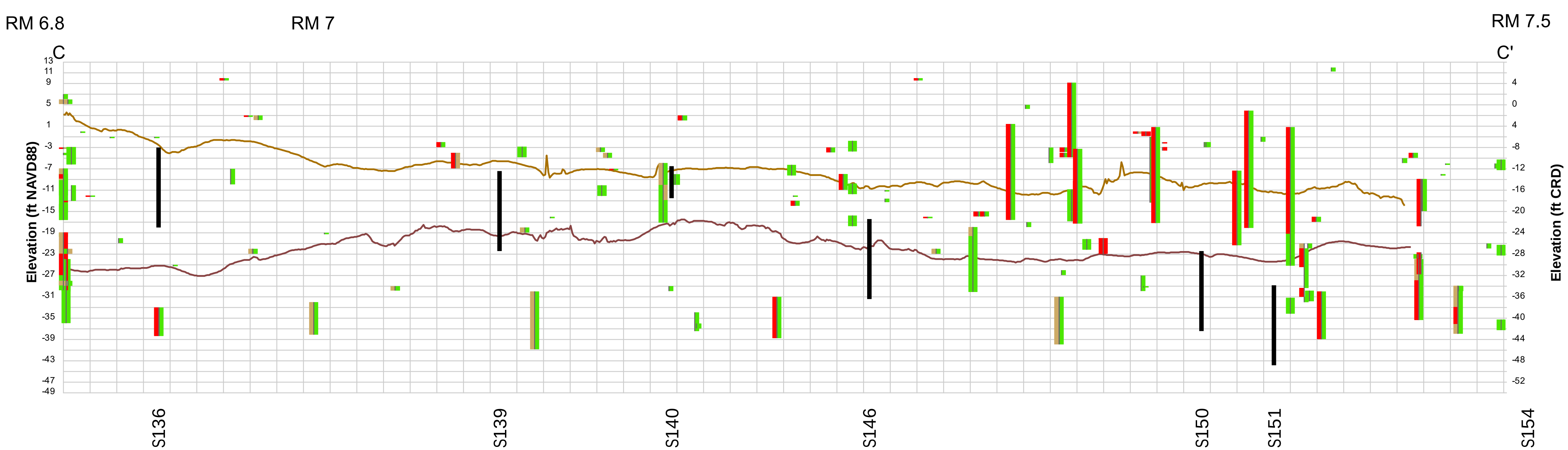
SS/JR | 18-Jan-2018

Figure **4b**

Path: P:\GIS\PortlandHarbor\Workplan\GIS\XS\PHSS_XSection_B.mxd





Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap

- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Shallow Mudline
- Approximate Toe of Slope Mudline
- Proposed Core Location and Grab RI Core Location and Depth

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. RIFS cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88
3. Aerial Imagery provided by ESRI Basemaps 2017.

EPA Record of Decision (ROD) Table 17

Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

10X Vertical Exaggeration

0 200 400 800 Feet

Section C - C'

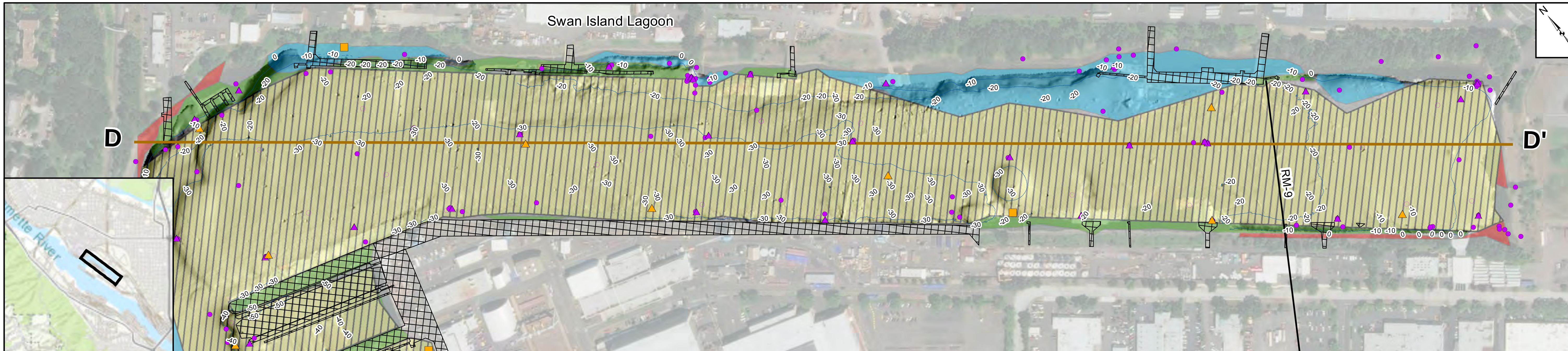
Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

AECOM Geosyntec consultants

Figure **4c**

SS/JR 18-Jan-2018

Path: P:\GIS\PortlandHarbor\Workplan\GIS\FSP\HSS_XSection_C.mxd



Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker
- Edge of Alt F Mod SMA Footprint

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Mudline
- Proposed Core Location and Grab RI Core Location and Depth

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. RIFS cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88
3. Aerial Imagery provided by ESRI Basemaps 2017.

EPA Record of Decision (ROD) Table 17

Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

10X Vertical Exaggeration

0 200 400 800 Feet

Section D - D'

Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

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SS/JR 18-Jan-2018

Figure 4d

APPENDIX A

Field Forms and Checklists

- Sediment Sampling Equipment Checklist
- Portland Harbor PDI Subsurface Sediment Core Collection Log
- Portland Harbor PDI Subsurface Sediment Core Processing Log
- Portland Harbor PDI Sediment Sample Logging Key
- Corrective Action Record
- Field Change Request
- Chain of Custody/Laboratory Analysis Request Form

SEDIMENT SAMPLING EQUIPMENT CHECKLIST

Safety Equipment
boots, waterproof, steel-toed
gloves, nitrile, heavy outer
gloves, nitrile, thin inner
hard hats
hearing protection
rain slicks
safety glasses/goggles
butcher apron or Tyvek for decon
Personal Flotation Devices (PFDs)
throw ring
first-aid kit
warm/dry clothes
cell phone, fully charged
bottled water
snacks
float plan

Sample Handling
bowls, large, stainless
spoons, small, stainless
spoons, large, stainless
bottleware, sample analyses specific
sample labels
sampler, grab sampler [2]
sampler, core and tubes [1]
core caps
core catchers

Tools
hacksaw [1]
drywall blade, 6-inch
ruler (12 inch/30 centimeter)
measuring tape [1]
rubber mallet [1]
screwdrivers (Phillips, flat)
siphon tubes [2]
utility knife
lead line (if not on vessel)

Supplies
handheld GPS, fully charged
camera
gas for boat, if applicable
keys for boat, if applicable
white board, white board markers
bags, plastic zip, gallon-size
bags, plastic zip, quart-size
duct tape
electrical tape
ice
logs, field [3]
field books
paper towels
pens, ballpoint, permanent [3]
Sharpies, small and large
trash bags
zip ties
4-inch pipe clamps
core carrying box

Decon Equipment
brushes, long-handled
brushes, short-handled
detergent, laboratory (e.g., Alconox)
methanol/hexane in dispensing bottle (optional)
nitric acid, 10% in dispensing bottle (optional)
5-gallon buckets, or similar
aluminum foil
water, distilled in dispensing bottle

Plans
Field Sampling Plan [3]
Maps
Health and Safety Plan

[1] Core Sampling Specific
[2] Grab Sampling Specific
[3] Write-in-rain or other waterproof paper/pens are recommended.

Portland Harbor PDI Sediment Core Collection Log

Core Location #:______________
Core Collection Date:___/____/____

GPS Location Code:	
Weather Conditions:	
Tide (CRD):	
Water Depth (ft):	

Sampling Personnel:
Field:
Contractor:

Sampling Type (vibracore, tube ID): Core Tube Length:

Proposed Coordinates: N: E: Elev:

Core Location and Attempts								
		Actual Coordinates						
Attempt #	Time	Northing	Easting	Accepted (Y/N);	Penetration Depth (ft)	Recovery Length (ft)	Recovery (%)	Drive Description (free fall, fingers inverted, vibration needed to drive/extract, debris encountered, refusal, etc):

If core sectioned in the field for transport:

Core Tube Length (ft):

Section:	Length (ft):	Description at Cuts:
A =		
B =		
C =		
D =		

EPA Oversight During Sample Collection? No Yes

Additional Comments

Portland Harbor PDI Sediment Core Processing Log

Core Location #:______________
Core Collection Date:___/____/____

Processing Date:	
Core Sample/Station ID:	
Analytical Suite (circle one):	Four Focused COCs

Core Processing Personnel:

Sediment Description

Recovered Length (ft)	% Compaction	Color	Size % - G	Size % - S	Size % - F	Description (moisture, density, color, grain size, sheen/odor, biota/debris)	Insitu Actual Depth (ft)	Sample Depth (ft)	Subsample No.	Summary Sketch
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

*Use line weights indicated in logging key to illustrate major/minor contacts.

Primary Sample Information

Subsample ID	Time	Containers	Subsample ID	Time	Containers

QA/QC Report

Sample ID	Time	Containers	QA/QC Type	Primary Sample

EPA Oversight During Sample Processing? No Yes

Additional Comments

Portland Harbor PDI
Sediment Sample Logging Key

Visual Sediment Descriptions consist of the following:

- Moisture content
- Density/consistency (estimated based on visual observation)
- Color (Munsell Number)
- Major/Minor Contituents
- Amount and shape of minor constituents and major constituent structure
- Sheen and odor
- Redox potential discontinuity

Example: wet, soft, olive green (GLEY 1, 5/10Y) clayey SILT, little sand, moderate shell fragments, and trace twigs and rootlets. Silt texture is uniform, slightly compressible, massive, blocky, and of low plasticity. Slight odor and trace sheen. RPD 1 cm.

Sediment Description Terminology: Estimated based on visual observations

Moisture Content

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content, no visible water
Wet	Visible free water, probably above optimum

Density: Visual Core Drive Penetration

SAND or GRAVEL		SILT or CLAY
Density	**Visual**	**Consistency**
Very loose	freefall	Very soft
Loose	easy penentration	Soft
Medium dense	moderate penentration	Medium stiff
Dense	hard penentration	Stiff
Very dense	refusal	Very Stiff/Hard

Color descriptions in Munsell Charts

MAJOR and Minor Constituent % (by weight)

Core Logs	Percent	Field Logs
Trace (clay, silt, etc.)	0–5	not identified
Few (clay, silt, etc.)	5-15	Slightly (clayey, silty, etc.)
Little (clay, silt, etc.)	15-30	Clayey, silty, sandy, gravelly
Clayey, silty, sandy, gravelly	30-50	Very (clayey, silty, sandy, etc.)
GROUP NAME	> 50	GROUP NAME

Other Minor Constituents: % (by volume)

(i.e., shells, wood, organics, plastic, non-native debris)

Trace	0-5
Scattered	5-10
Moderate	10-30
Substantial	30-50
GROUP NAME	> 50

Structure

Stratified	Alternating layers of varied material/color at least 1/4" thick
Laminated	Alternating layers of varied material/color at least 1/4 mm thick
Blocky	Cohesive soil that can be broken down into smaller lumps
Spongy	Organic and compressible nature
Lensed	Inclusion of thin discontinuous layers of different sediment
Homogenous/Massive	Same color and appearance throughout
Fibrous	Stringy or rope like structure
Seam	1/16 to 1/2" thick
Layer	greater than 1/2" thick
Interbedded	Multiple beds within a unit
Rolls Easily	Play-dough like (plasticity observation)
Angular	Sharp edges
Subangular	Rounded edges
Subrounded	Well-rounded edges
Rounded	Smoothed, no edges

Odor Descriptions

none
trace
slight
moderate
strong

Sheen Test- % coverage

S.T. = Sheen test visual analysis	
none, trace	<2
slight sheen	2-15
moderate sheen	15-40
moderate to heavy	40-70
heavy	>70

Sheen Test- Visual Description

rainbow	multicolored
metallic	metallic gray-colored
florets	semi-circular and multicolored
streaks	long and flowing shape

Other Sediment Descriptions Used

Agglomerate	Fused-appearance, often vesicular
Clast/inclusion	Non-fused appearance
Xenoclasts	Clasts that have been moved
Fresh	No visible sign of decomposition or discoloratior
Winnowed	Loss of fines
Slumped	Settled but intact
Pockets/balls	Semicircular to circular inclusion/deposit
Chunky	Mass of unidentified material

Sediment Core Log Guidelines for line Weights

	color or minor change (dashed line)
	major sediment change (solid line)
	depositional change (heavy line)

Core Acceptance Guidelines

1. Desired drive/penetration depth is reached.
2. Core recovery is greater than 80%.
3. Core tube appears intact (no signs of blocking, bending).
4. Minimal sediment loss out the top or bottom (minimal winnowing).

Grab Acceptance Guidelines

1. No or minimal excess water leaking from the jaws of the sampler.
2. No excessive turbidity in the overlaying water of the sampler.
3. Sampler did not over-penetrate.
4. Sediment surface appears to be intact with minimal disturbance.
5. Program-specific penetration (30 centimeters) has been achieved.

NOTES:

*Classification of sediment on core logs is based on visual field observations.
Classification notes should not be construed to imply laboratory testing unless presented herein. Unified Soil Classification System ASTM D-2487 and Visual-manual classification method ASTM D-2488 for the description and identification of soils were used as an identification guide.

CORRECTIVE ACTION RECORD

Page ____ of ____ Audit Report No.: ____________________________ Date: ______________________

Report Originator: ___________________________________

Person Responsible for Response: ___________________________________

DESCRIPTION OF PROBLEM:

Date and Time Problem Recognized: ___________________________________ By: ___________________________________

Date of Actual Occurrence: ___________________________________ By: ___________________________________

Analyte: ___________________________________ Analytical Method: ___________________________________

Cause of Problem:

CORRECTIVE ACTION PLANNED:

Person Responsible for Corrective Action: ___________________________________ Date of Corrective Action: ____________________________

Corrective Action Plan Approval: ___________________________________ Date: ______________________________

DESCRIPTION OF FOLLOW-UP ACTIVITIES:

Person Responsible for Follow-up Activities: ___________________________________ Date of Follow-up Activity: ____________________________

Final Corrective Action Approval: ___________________________________ Date: ______________________________

FIELD CHANGE REQUEST

Page ____ of ____ Field Change No.: ____________________ Project Number: ______________________

Project Name: ____

CHANGE REQUEST

Applicable
Reference: ____

Description of Change:

Reason for Change:

Impact on Present and Completed Work:

Requested by: ____ Date: ______________________________
(Field Scientist)

Acknowledged by: _____________________________________ Date: ______________________________
(Field Task Leader)

SAMPLING AND ANALYSES COORDINATOR RECOMMENDATION

Recommended Disposition:

Recommendation by: ___________________________________ Date: ______________________________

CERCLA COORDINATOR APPROVAL

Notification Requred: Yes / No

Final Disposition:

Approved/Disproved by: ________________________________ Date: ______________________________

EPA PROJECT MANAGER APPROVAL

Approved/Disproved by: ________________________________ Date: ______________________________

CHAIN OF CUSTODY/LABORATORY ANALYSIS REQUEST FORM

Page ______ of ______ Turn Around Requested: ________

Report to:	Phone:				Analyses Requested										Notes/Comments
Company:	Fax:														
Address:	Proj Name:														
City:	Proj Number:														
State:	Sampler:														
Zipcode:															
Sample ID	Sample Date	Sample Time	Sample Matrix	No. Containers											

Relinquished: (Signature)	Received by: (Signature)	Special Instructions/Notes	
Printed name:	Printed name:		
Company:	Company:		Number of Coolers:
			Cooler Temp(s):
Date: Time:	Date: Time:		COC Seals Intact?
			Bottles Intact?

APPENDIX B

- Hydrocarbon Field Screening by Sheen Test SOP
- Field Description Key for Potential NAPL in Sediments

Appendix B1.
Standard Operating Procedure
Hydrocarbon Field Screening by Sheen Test

1.0 Purpose and Applicability

The Standard Operating Procedure (SOP) for sheen test describes a procedure to visually estimate areas of possible hydrocarbon impacts in soil or sediment. In addition, screening results can be used to aid in the selection of soil/sediment samples for chemical analysis. The field screening method includes a visual examination and water jar screening test.

Visual screening consists of inspecting the soil/sediment for stains, nonaqueous-phase liquids (NAPL), and/or sheens indicative of residual hydrocarbons. Visual screening is most effective at detecting heavy hydrocarbons, such as creosote, free-phase NAPL or high hydrocarbon concentrations. Water sheen screening from a representative soil/sediment sample is a more sensitive method at detecting the presence of hydrocarbons.

2.0 Responsibilities

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The field sampling coordinator will have the responsibility to oversee and ensure that all sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

3.0 Health and Safety

This section presents the potential hazards associated with this technique. The site-specific Health & Safety Plan (HASP) will take precedence over this document. Note that sample collection usually requires Level D personal protection unless there is a potential for airborne or dermal exposures to site contaminants.

Health and safety hazards include but are not limited to the following:

- Dermal exposure to potentially contaminated media: proper personal protective equipment (PPE) is used to mitigate dermal contact including the impact of splashes of water or media to skin and/or eyes;
- Inhalation exposure when handling impacted media: respiratory protection should follow the procedures outlined in the project Site-Specific HASP; and
- Broken glass, in the event that a glass jar is used: use care when handling glassware.

4.0 Supporting Materials

The following materials must be on hand in sufficient quantity to ensure that proper screening procedures may be followed:

- Approximately one cubic-inch of media to be screened;
- 4 of 8 oz. wide-mouth, clear glass jar;
- Stirring devise (i.e. spoon);
- Squirt bottle; and
- Supply of distilled water.

5.0 Methods and Procedures

The strategy used to collect soil/sediment samples in the field for sheen testing will depend on the nature/grain size of the material and the type of hydrocarbon. Discrete samples may be collected from specific depths where NAPL is likely to occur. When lithology is course-grained material over fine-grained material, then a sample should be collected just above this interface where NAPL may be pooling above the "aquitard". Similarly, where fine-grained material overlies a coarse-grained layer with suspected impacts, the sample should be collected just below the contact. When lithology is fine-grained, then a sample should be collected near the contact with the coarse-grained layer. Alternatively, when lithology is finely bedded (< 1-inch thick), then homogenized samples may be collected over a larger depth interval to gain an "average" observation.

If the sample is being collected from inside a sediment core tube, the tube should be cut open longitudinally along the length of the core tube to prevent additional smearing. Make sure the interior of the sediment is exposed as a "fresh surface". Be sure to discard any material along the inside side-walls of the core tube; this is called the "smear zone". The smear zone may mask the true stratigraphy of a subsurface core sample. Then, use a spoon to scrap material across the "fresh" surface of the depth interval of interest, and place into sample jars for further observation. Once the sample volume is collected (approximately 1 oz or more depending upon grain size) the sample is examined and tested as described below.

Visual Examination

In the field, observe sediment core tubes or soil samples for evidence of NAPL. Look at the material and note color and type/nature of occurrence. Observe the exterior and interio sidewalls of the sampling container for signs of staining. If wet, observe the nature of liquid. Among gravels, observe the surface of the gravel for signs of sheen and/or NAPL.

Water Sheen Test

Water sheen screening involves placing soil/sediment in a clear glass jar or a black plastic pan partially filled with water, and observing the water surface for signs of a sheen. The volume of soil/sediment required for observation is approximately one cubic inch, or 10 mls, or about one tablespoon of media. For practical application in the field or lab, place about one cubic inch of soil/sediment (roughly 1 oz) in a 4 to 8 oz jar filled ¼-full with water. For larger volumes, use about 2 oz of material in an 8 oz wide-mouth glass jar filled ¼-full with water. Even larger volumes are needed for gravel. A plastic baggy may be substitute for a glass jar if field conditions require. Crush the material in the jar using a stirring devise (i.e., spoon), and shake the sealed jar vigorously for 30 seconds and allow the material to settle. Observe the water surface and sidewalls of the jar for signs of sheen, LNAPL, and DNAPL. Quantify the amount of sheen and blebs in the water surface using the following sheen classification:

No Sheen	No visible sheen on water surface
Slight Sheen	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly
Moderate Sheen	Light to heavy sheen, may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas without sheen on water surface
Heavy Sheen	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen; visible droplets of immiscible liquids (i.e. NAPL)

Quantify the spatial coverage of sheen and size/diameter NAPL blebs if observed. The color is often described as rainbow or metallic for sheens and dark brown to black for blebs, droplets, and staining. Observe the sidewalls of the jar and estimate the thickness of LNAPL on the water surface and the thickness of DNAPL accumulated at the bottom of the jar. Record visual signs of staining on jar sidewalls and stirring devise.

Field screening results will be recorded on the field logs forms or in a field notebook. Field screening results are site-specific and location-specific. Factors that may affect the performance of this method include: operator experience (experimentation may be required before routine screening is started) ambient air temperature, soil type, soil moisture, organic content, and type of hydrocarbon. Headspace screening may be collected to help correlate results and observations.

6.0 Quality Assurance/Quality Control

Not applicable.

7.0 Documentation

Documentation may consist of all or part of the following:

- Field sampling forms;
- Field log book; and
- Chain-of-custody forms.

Field records should contain sufficient detail to provide a clear understanding of how and where samples were collected. All documentation shall be placed in the project files and retained following completion of the project.

Appendix B2

Field Description Key for Potential NAPL in Sediment

The intent of this field description key is to provide field personnel with guidelines for logging and observing sediment conditions associated with potential presence of Non-Aqueous Phase Liquid (NAPL) in a consistent and factual manner.

VISUAL DESCRIPTORS

The range of conditions that could exist in sediments include:

- **NAPL** (Non-Aqueous Phase Liquid) – a separate phase liquid that may be lighter than water (LNAPL) or denser than water (DNAPL). NAPL can have varying consistency (viscosity) and can range from non-viscous to highly viscous (taffy-like). NAPL observations should be accompanied by applicable olfactory with smell (see descriptors below) and other visual observations (e.g., color and viscosity). The visual appearance of NAPL should be noted using descriptors below as appropriate. If NAPL is identified, then a sheen or shake test should be completed as described in this SOP in the Hydrocarbon Field Screening by Sheen Test portion.
    - **Free Product –** the entirety of the pore space for a sample interval is saturated with NAPL. Care should be taken to ensure that the saturation described is not related to water in the sample. Depending on the viscosity, NAPL saturated materials may freely drain from a soil sample and should be documented accordingly.
    - **Present–** In some cases, NAPL may be present in the pore spaces, or some of the pore spaces, but not coating the soil grains. The NAPL occurrence may be greater than blebs but not freely draining (saturated) and not hydraulically continuous. In these cases, the appearance/abundance of the NAPL should be noted.
    - **Blebs or Globules–** discrete, multi-shaped NAPL in or on the soil matrix. Include additional descriptors to the extent practicable such as the approximate size (typically ranging in size from 0.01 to 0.05 inches in diameter) and quantity (number of blebs or qualitative estimate) to the extent practical.
    - **Coated –** soil grains are coated with NAPL – there is <u>not</u> sufficient NAPL present to saturate the pore spaces. Use modifiers such as light, moderate or heavy to indicate the degree of coating.
    - **Semi-solid NAPL–** NAPL that is present as a super viscous liquid and appears in a solid or semi-solid phase. The magnitude of the observed solid NAPL should be described (discrete granules, tarry balls, taffy-like, or a solid layer).
- **Sheen –** iridescent sheen. The sheen characteristics need to be described in the field log, including the color, and iridescent sheens need to be distinguished from bacterial sheens which tend to break up at angles on the water surface; whereas a non-bacterial sheen will be continuous and will not break up. Sheens can be described as:
    - Discontinuous sheen (i.e., spotty, streaks, florets) within a section of core and does not fill sediment pore spaces.

- Continuous sheen (i.e., covering an area greater than 1 square inch) within a section of core but does not fill pore spaces. Describe percent cover.

- **Stained –** visible, unnatural discoloration of the soil, with no visible NAPL.

Other Visual Impacts and Descriptors

In many cases, observed NAPL may be associated with a particular stratigraphic layer (e.g, sand lamination, woody debris layer, gravel lense), gas bubble, or void; NAPL distribution in relation to stratigraphy must be described. What does the material look like immediately above and below the area with suspected NAPL (e.g, clay). Impacts should be described using other visual descriptors as well, as applicable. Descriptors may include, but not be limited to, color, consistency, thickness, viscosity, water content, associated stratigraphy, presence shell or wood fragments or other debris, does NAPL flow out of the core tube, does it appear more or less viscous than water, results of jar sheen test, etc. Also note the staining of sampling equipment, and interior and exterior side-walls of the sampling tube, especially if entrainment of NAPL up the side-walls is suspected as an artifact of sample collection.

OLFACTORY DESCRIPTORS

Field personnel will not conduct olfactory testing as part of sample processing, because vapor inhalation is a potential health and safety risk. However, if incidental odors are noted by field personnel during regular sample processing activities, field personnel will record this observation in the field forms. General descriptors that could be used are the following:

- Note odors similar to mothballs, driveway sealer, highway paving oil, sewage or other odors that are acrid, burnt, or sulfur-like, etc.
- Other odors that are not believed to be natural should also be identified with descriptors such as organic, ammonia, sweet, chemical etc., as applicable.
- Use modifiers such as strong, moderate or slight to indicate intensity of the observed odor.
- In instances where multiple odors are present, a combination of descriptors should be used to clearly identify where these co-mingled impacts are present.

However, olfactory descriptions are more subjective than visual inspections. Visual inspection may be aided by a PID, ultraviolet (UV) fluorescence examination, shake test, or similar device, to monitor and record organic odors and suspected NAPL in the field. One may also consider collecting a sample of the suspected NAPL to assess physical characteristics and potential mobility.

Last revised by AGF and Geosyntec on 1/18/18
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